Instruction Manual

MODEL 881A & 881AB

DC DIFFERENTIAL VOLTMETER

FLUKE

ELECTRONICS FOR INDUSTRY
INSTRUMENTS / COMPONENTS

JOHN FLUKE MFG. CO., INC.
P.O. Box 7428 Seattle, Washington 98133

OCTOBER 1, 1965

MODEL 881A & 881AB

DC DIFFERENTIAL VOLTMETER

881A & 881AB serial no. _____ and above

Warranty

The JOHN FLUKE MFG. CO., INC. warrants each instrument manufactured by them to be free from defects in material and workmanship. Their obligation under this Warranty is limited to servicing or adjusting an instrument returned to the factory for that purpose, and to making good at the factory any part or parts thereof; except tubes, fuses, choppers and batteries, which shall, within one year after making delivery to the original purchaser, be returned by the original purchaser with transportation charges prepaid, and which upon their examination shall disclose to their satisfaction to have been thus defective. If the fault has been caused by misuse or abnormal conditions of operation, repairs will be billed at a nominal cost. In this case, an estimate will be submitted before work is started, if requested.

If any fault develops, the following steps should be taken:

1. Notify the John Fluke Mfg. Co., Inc., giving full details of the difficulty, and include the Model number, type number, and serial number. On receipt of this information, service data or shipping instructions will be forewarded to you.

2. On receipt of the shipping instructions, forward the instrument prepaid, and repairs will be made at the factory. If requested, an estimate of the charges will be made before the work begins, provided the instrument is not covered by the Warranty.

SHIPPING

All shipments of John Fluke Mfg. Co., Inc. instruments should be made via Railway Express prepaid. The instrument should be shipped in the original packing carton; or if it is not available, use any suitable container that is rigid. If a substitute container is used, the instrument should be wrapped in paper and surrounded with at least four inches of excelsior or similar shock-absorbing material.

CLAIM FOR DAMAGE IN SHIPMENT

The instrument should be thoroughly inspected immediately upon receipt. All material in the container should be checked against the enclosed packing list. The manufacturer will not be responsible for shortages against the packing sheet unless notified immediately. If the instrument fails to operate properly, or is damaged in any way, a claim should be filed with the carrier. A full report of the damage should be obtained by the claim agent, and this report should be forwarded to John Fluke Mfg. Co., Inc. Upon receipt of this report you will be advised of the disposition of the equipment for repair or replacement. Include the model number, type number, and serial number when referring to this instrument for any reason.

The John Fluke Mfg. Co., Inc. will be happy to answer all application questions which will enhance your use of this instrument. Please address your requests to: JOHN FLUKE MFG. CO., INC., P.O. BOX 7428, SEATTLE, WASHINGTON 98133.

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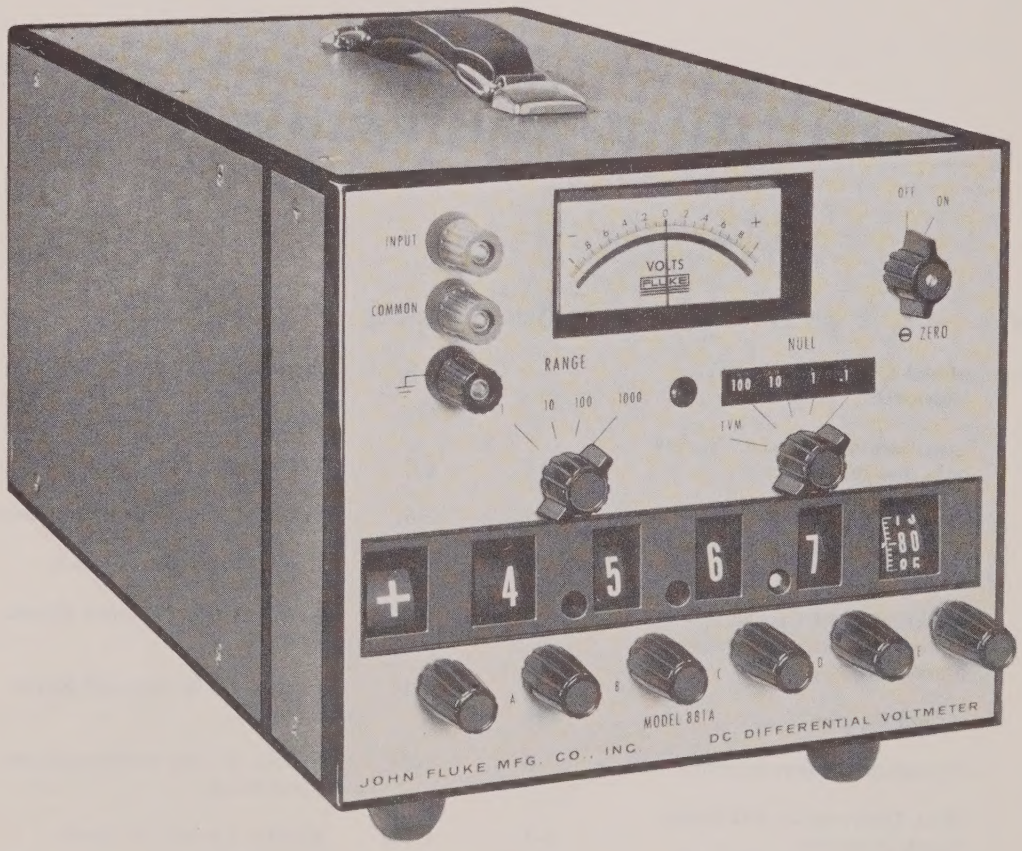


881A SOLID STATE DC DIFFERENTIAL VOLTMETER

SECTION I

INTRODUCTION AND SPECIFICATIONS

1-1. INTRODUCTION

1-2. This instruction manual is for use with the 881A series Differential DC Voltmeters. These are available as either a line-powered instrument (Model 881A) or as a combination line-powered or battery-powered instrument (Model 881AB). Both instruments are half rack size and are equipped with resilient feet and tilt-up bail for field or bench use. A single instrument may be mounted in a standard 19 inch rack by means of metal handle rack adapter kit 881A-102. Two instruments may be mounted side-by-side by means of metal handle rack adapter kit 881A-103.

1-3. The 881A series instruments are capable of being used as conventional voltmeters for rapid determination of dc voltages from 0 to 1100 volts to within ±3% of range setting, as differential voltmeters for precise measurement of dc voltages from 0 to 1100 volts to within ±(0.01% of input voltage + 5 uv), and as megohmmeters for measurements of resistance from 10 megohms to 11,000 megohms with a typical accuracy of 5%. They can also be used to measure the excursions of a voltage about some nominal value. One feature that should be emphasized is that no current is drawn from the unknown source at null up to 11 volts. Thus the determination of the unknown potential is independent of its source resistance. Above 11 volts, the input resistance is an excellent 10 megohms. To minimize errors due to common mode voltages, the 881A series is provided with extremely high leakage resistance to ground --- typically several hundred thousand megohms. Also, where ground loops errors are a problem, the battery operated mode of the 881AB eliminates these errors due to complete isolation from the power line. As additional features, the 881A series contains a polarity switch for equal convenience in measuring positive or negative voltages and an adjustable recorder output which makes the instrument particularly useful for monitoring the stability of almost any dc voltage. Furthermore, thorough shock, vibration, humidity, and temperature testing assure years of hard use under severe environmental conditions.

1-4. When used as a differential voltmeter, the 881A operates on the potentiometric principal. An unknown voltage is measured by comparing it to a known adjustable voltage with the aid of a null detector. An accurate standard for measurement is obtained from an 11 volt reference supply derived from a pair of temperature-compensated zener diodes. The known adjustable reference voltage is provided by a Kelvin-Varley voltage divider with four decades of FLUKE precision wirewound resistors and a high-resolution interpolating vernier that are set accurately by five voltage readout dials to give a six digit readout. In this way, the 11 volts can be precisely divided into increments smaller than 10 microvolts. The unknown voltage is then simply read from the voltage dials. For voltages between 11 and 1100 volts, an input attenuator divides the unknown voltage by 100 before it is measured potentiometrically.

1-5. INPUT POWER

1-6. Like most FLUKE instruments, the 881A is normally supplied with dual primary windings connected in parallel for 115 volt line operation. Upon request, the instrument is supplied for 230 volt line operation with the primary windings connected in series. If it becomes desirable to convert from one mode of operation to the other, refer to the instruction decal on the power transformer.

1-7. DAMAGE IN SHIPMENT

1-8. Immediately upon receipt, thoroughly inspect the instrument for any damage that may have occurred in transit. If any damage is noted, follow the instructions outline on the warranty page at the back of this manual.

1-9. SPECIFICATIONS

AS A DIFFERENTIAL VOLTMETER

ACCURACY: ± (0.01% of input voltage + 5 uv) over the complete operating conditions listed under general specifications.

ACCURACY UNDER CONTROLLED ENVIRONMENT: ± (0.005% of input voltage + 0.0002% of range setting + 5 uv) at 73° F (23° C). Derated at 0.0002%/° F (0.0004%/° C) from 73° F (23° C) between 55° F and 95° F (13° C and 35° C).

RANGE:

Voltage Range	Recommended Input Voltage	Null Range	Input Resistance at Null
1	0 to 1.1	0.1-0-0.1	Infinite
		0.01-0-0.01	Infinite
		0.001-0-0.001	Infinite
		0.0001-0-0.0001	Infinite
10	1 to 11	1-0-1	Infinite
		0.1-0-0.1	Infinite
		0.01-0-0.01	Infinite
		0.001-0-0.001	Infinite
100	10 to 110	10-0-10	10 Meg
		1-0-1	10 Meg
		0.1-0-0.1	10 Meg
		0.01-0-0.01	10 Meg
1000	100 to 1100	100-0-100	10 Meg
		10-0-10	10 Meg
		1-0-1	10 Meg
		0.1-0-0.1	10 Meg

NOTE: Each voltage range and each null range has the capability of measuring 10% over voltage.

RESOLUTION:

Voltage Readout Dial Resolution			
Voltage Range	Null Range	Resolution	
		ppm of Voltage Range	Volts
1	any	1 ppm	1 uv
10	"	1 ppm	10 uv
100	"	1 ppm	100 uv
1000	"	1 ppm	1 mv

Meter Resolution (1/2 of a small meter scale division)		
Voltage Range	Null Range	Resolution
any	0.0001	1 uv
"	0.001	10 uv
"	0.01	100 uv
"	0.1	1 mv
"	1	10 mv
"	10	100 mv
"	100	1 v

AS A CONVENTIONAL VOLTMETER

ACCURACY: ± 3% of range

RANGE:

Voltage Range	Input Resistance
1000-0-1000	10 Meg
100-0-100	"
10-0-10	"
1-0-1	"
*0.1-0-0.1	"
*0.01-0-0.01	"
*0.001-0-0.001	1 Meg
*0.0001-0-0.0001	"

* These ranges are obtained by using null ranges with all five voltage dials set to zero.

NOTE: Each range has the capability of measuring 10% overvoltage.

GENERAL

ELECTRICAL DESIGN: Completely solid-state.

INPUT RESISTANCE OF NULL DETECTOR: 10 megohms on two highest null ranges for all input ranges; 1 megohm on two lowest null ranges for all input ranges.

REFERENCE ELEMENT: Temperature-compensated zener diode, stability within ±15 ppm per year, and temperature coefficient less than 2 ppm/^{o}C.

REGULATION OF REFERENCE SUPPLY: 0.0005% for a 10% line voltage change.

STABILITY OF REFERENCE SUPPLY: ±0.001% per hour after 5 minute warmup.

ACCURACY OF OFF-NULL DEFLECTION: ±5% of null range (±3% with voltage dials to zero).

KELVIN-VARLEY ACCURACY: ±0.002% of setting from 1/11 of full scale to full scale. Ratio stability of decade resistors, 10 ppm/year.

RECORDER OUTPUT: Adjustable from 0 to at least +20 mv for full scale right deflection and from 0 to at least -20 mv for full scale left deflection.

POLARITY: Reversible via front panel switch.

WARMUP TIME: 15 seconds.

COMMON MODE REJECTION: 130 db at dc; 85 db at 60 cps; 70 db at 400 cps. Up to 1000 vdc may be applied between common and ground posts without damage. NOTE: Battery operation of Model 881AB provides complete isolation from power system ground, for elimination of errors due to ground loops.

OPERATING TEMPERATURE RANGE: Within specifications from 55^{o}F to 95^{o}F (13^{o}C to 35^{o}C), derated at 0.0004%/^{o}F (0.0007%/^{o}C) outside these limits to 32^{o}F and 122^{o}F (0^{o}C and 50^{o}C).

STORAGE TEMPERATURE RANGE: Model 881A, -40^{o}F to +158^{o}F (-40^{o}C to +70^{o}C); Model 881AB, -40^{o}F to +140^{o}F (-40^{o}C to +60^{o}C).

SHOCK: Meets requirements of MIL-T-945A and MIL-S-901B.

VIBRATION: Meets requirements of MIL-T-945A.

INPUT POWER: Model 881A - 115/230 vac ±10%, 50 - 440 cps; Model 881AB - 115/230 vac ±10%, 50 - 440 cps and rechargeable battery operation (minimum 30 hours operation on full charge).

SIZE: 7" high x 8-1/2" wide 14-3/4" deep.

WEIGHT: Model 881A - approximately 13 lbs.
Model 881AB - approximately 14 lbs.

SECTION II

OPERATING INSTRUCTIONS

2-1. CONTROLS, TERMINALS, AND INDICATORS

2-2. The location, circuit symbol, and a functional description of the external controls, terminals, and indicators on the 881A and 881AB Precision Differential DC Voltmeter may be found in figure 2-1 and 2-2.

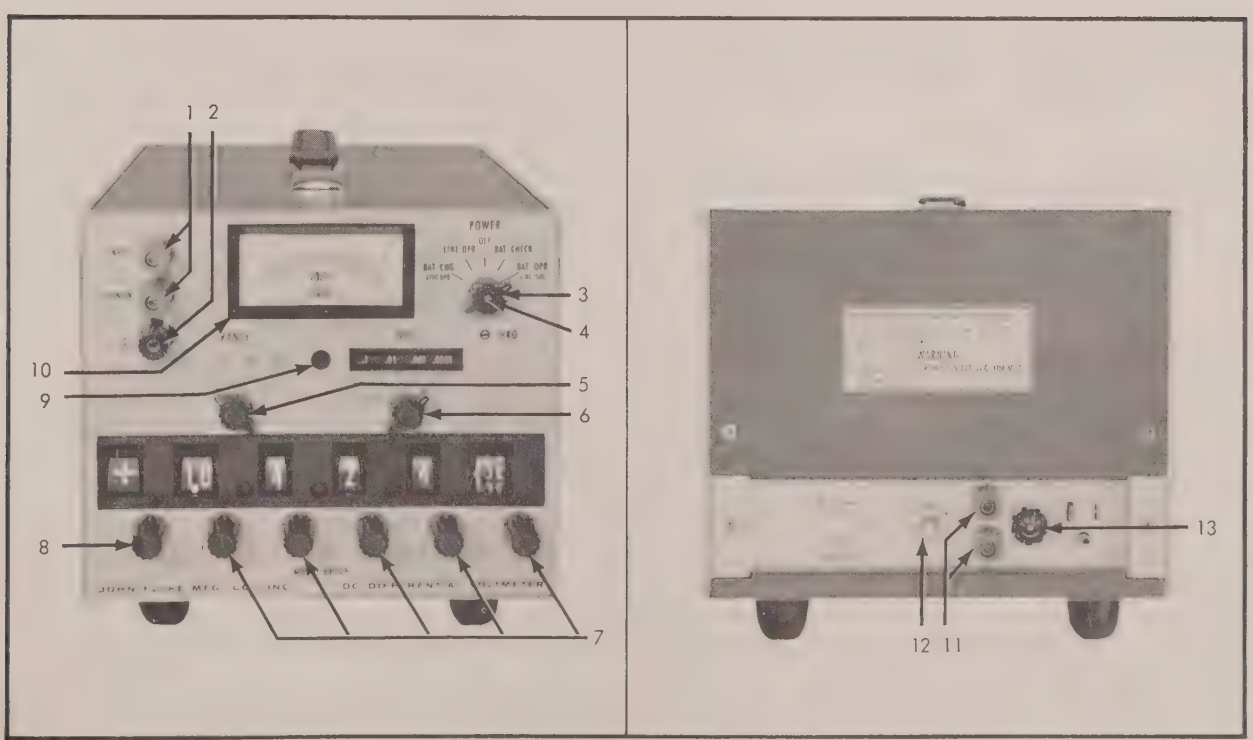


Figure 2-1. LOCATION OF CONTROLS, TERMINALS, AND INDICATORS

INDEX NO.	CONTROLS TERMINALS AND INDICATORS	CIRCUIT SYMBOL	FUNCTIONAL DESCRIPTION
1	INPUT and COMMON terminals	J1, J2	Provided for connecting dc voltage to be measured.
2	Chassis ground terminal	J3	Provided for grounding purposes. A 0.01 uf capacitor is connected from the COMMON binding post to the chassis ground post. The INPUT post should never be connected to the chassis ground post. Since the instrument is equipped with a three-wire line cord with the third wire fastened to the chassis, the circuit should be checked for conflicts in grounding before connecting COMMON binding post to the chassis post.
3	POWER switch	S1	In the Model 881A, the POWER switch applies ac line voltage to primary circuit of transformer when turned from OFF to ON. In the Model 881AB, positions for OFF, BAT CHECK, and three modes of operation (LINE OPR, BAT CHG - LINE OPR, and BAT OPR - LINE ISOL) are available. When set to LINE OPR, ac line voltage is applied to primary circuit of transformer. When set to BAT CHG - LINE OPR, ac line voltage is applied to primary of transformer and batteries are charged at the same time. When set to BAT OPR - LINE ISOL, battery power is applied to the instrument and both sides of primary circuit are open. When set to BAT CHECK, battery power is applied to the instrument, both sides of primary circuit are open, and meter is connected in series with a resistor to measure voltage between reference supply batteries and reference supply output which indicates the condition of the batteries.
4	Electronic ZERO control	R239	A screwdriver adjustment used to zero null detector in the .0001 volt null mode on the 1 volt range and in the .01 volt null mode on the 100 volt range. For best results, input should be shorted prior to zeroing.
5	RANGE switch	S2	Selects desired voltage range, changes null ranges appearing in NULL window, and positions decimal point for voltage readout dials. Voltage ranges of 1, 10, 100, and 1000 volts are available. A voltage 10% higher than range setting may be measured in each range.
6	NULL switch	S3	Set to TVM for determining the approximate value of unknown voltage prior to differential measurements. Seven null voltage ranges (four of which are used for each setting of the RANGE switch) of 100, 10, 1, 0.1, 0.01, 0.001, and 0.0001 volts are used for differential measurements. These ranges represent full scale differences between the unknown voltage and the amount of precision internal reference voltage that is set on the voltage readout dials.
7	A, B, C, D, and E voltage readout dials	S5, S6, S7, S8, R12	Provide an in-line readout of the amount of internal reference voltage necessary to null the unknown voltage.

Figure 2-2. DESCRIPTION OF CONTROLS, TERMINALS, AND INDICATORS (Sheet 1 of 2)

INDEX NO.	CONTROLS TERMINALS AND INDICATORS	CIRCUIT SYMBOL	FUNCTIONAL DESCRIPTION
8	Polarity switch	S4	Changes polarity of 881A to match polarity of unknown voltage. With this switch in the positive position, the polarity of INPUT binding post is positive with respect to COMMON binding post.
9	Mechanical zero control	None	Sets meter to zero mechanically. This adjustment should be used only after instrument has been turned off for at least three minutes or when the internal meter terminals have been shorted.
10	Meter	M1	Indicates approximate voltage when 881A is in TVM mode and difference between unknown and internal reference voltage when 881A is in differential mode.
11	RECORDER OUTPUT terminals	J4, J5	Provided for attaching a recorder to monitor voltage excursions.
12	AMP ADJ control	R10	Varies the output level of the output binding post from 0 to at least 20 millivolts at full scale deflection.
13	Fuse	F1	Fuse holder protrudes from instrument to provide easy access to the fuse. The fuse is a 1/16 ampere slow blowing type for 115 volt operation and a 1/32 ampere slow blowing type for 230 volt operation.

Figure 2-2. DESCRIPTION OF CONTROLS, TERMINALS, AND INDICATORS (Sheet 2 of 2)

2-3. PRELIMINARY OPERATION FOR MODEL 881A

2-4. The following procedure prepares the Model 881A for operation.

a. Connect power plug to a 115 volt ac power outlet. If instrument has been wired for 230 volt operation, connect to 230 volts ac.

WARNING

The round pin on polarized three-prong plug connects instrument case to power system ground. Use a three-to-two pin adapter when connecting to a two-contact receptacle. For personnel safety, connect short green lead to a good earth ground.

b. Set switches on 881A voltmeter as follows:

RANGE	1000
NULL	TVM
polarity	+ (positive)
all voltage readout dials	0 (zero)
POWER	ON

2-5. PRELIMINARY OPERATION FOR MODEL 881AB

2-6. The following procedure prepares the Model 881AB for operation.

a. For line operation, connect power plug to a 115 volt ac power outlet. If instrument has been wired for 230 volt operation, connect to 230 volts ac.

WARNING

The round pin on polarized three-prong plug connects instrument case to power system ground. Use a three-to-two pin adapter when connecting to a two-contact receptacle. For personnel safety, connect short green lead to a good earth ground.

b. For line operation, set POWER switch to LINE OPR.

c. For battery operation, set POWER switch to BAT CHECK. Meter needle should deflect to BATTERY OK region. If meter needle does not stay within BATTERY OK region for 10 seconds, charge batteries as outlined in paragraph 2-9. If batteries are charged, set POWER switch to BAT OPR-LINE ISOL.

d. Set switches on 881AB voltmeter as follows:

RANGE	1000
NULL	TVM
polarity	+ (positive)
all voltage readout dials	0 (zero)

2-7. ZEROING INSTRUCTIONS

2-8. From time to time, it may be necessary to adjust

the electronic meter zero control. This will normally be done at somewhat more frequent intervals than complete instrument calibration. Proceed as follows:

a. Perform preliminary operation as stated in paragraph 2-3 or 2-5.
b. Mechanically zero the meter with the adjustment screw on the front of the meter case. If the instrument is in the case, it must be shut off for at least three minutes prior to this adjustment. If out of case, another method would be to short out the internal panel meter terminals prior to zeroing.
c. Turn instrument on and allow a 5 minute warmup period.
d. Set RANGE switch to 1, voltage readout dials to zero, and NULL switch to 0.0001.
e. Short INPUT post to COMMON post and adjust electronic ZERO control with a screwdriver for zero meter deflection.
f. Remove short from between INPUT and COMMON post.

2-9. BATTERY CHARGING

a. Connect power plug to a 115 volt ac power outlet. If instrument has been wired for 230 volt operation, connect to 230 volts ac.
b. Set POWER switch to BAT CHG-LINE OPR. After 16 hours, batteries will be fully charged and capable of operating the instrument for at least 30 hours. While the batteries are being charged, the instrument may be operated the same as for line operation.

CAUTION

Since overcharging decreases battery life, it is recommended that the batteries be charged for less than 48 hours and never more than 1 week. When used properly, the batteries will give more than 200 charge-discharge cycles of operation.

2-10. OPERATION AS A DIFFERENTIAL VOLTMETER

a. Perform preliminary operation as stated in paragraph 2-3 or 2-5.
b. Connect unknown voltage between INPUT and COMMON post. If one side is grounded, always connect it to the COMMON post.
c. Turn RANGE switch to lowest range that will allow an on-scale reading and note approximate value of unknown voltage as indicated on meter scale.
d. If meter reads to left, turn polarity switch to negative position. The meter needle will deflect to right. This is because polarity of unknown voltage is negative.
e. Noting position of decimal point, set five voltage readout dials to approximate voltage determined in step c. For example, if voltage is approximately 35 volts, decimal point will be between B and C voltage readout dials. Therefore, set A dial to 3 and B dial to 5.
f. Set NULL switch from TVM to successively more sensitive null ranges and adjust voltage readout dials for zero meter deflection in each null position. When meter needle indicates to the right, magnitude of voltage under measurement is greater than voltage set on voltage readout dials. When indication is to the left, voltage is less than that set on readout dials.
g. Read unknown voltage directly from five voltage readout dials.

2-11. OPERATION AS A CONVENTIONAL VOLTMETER

2-12. If it is desired to use the instrument as a conventional 3% voltmeter only, additional ranges can be made available by converting the NULL ranges to conventional voltmeter ranges. This is made possible by setting the voltage readout dials to zero. Proceed as follows:

a. Perform preliminary operation as stated in paragraph 2-3 or 2-5.
b. Consult figure 2-3, and select full scale voltage deflection desired. If approximate value of voltage to be measured is unknown, select the 1000 volt range initially.
c. Set RANGE switch, NULL switch, and voltage dials as indicated for the range selected.
d. Connect voltage to be measured between INPUT and COMMON posts. If one side is grounded, always connect it to the COMMON post. Deflection to the right indicates that unknown dc voltage is of positive polarity.

2-13. MEASUREMENT OF VOLTAGE EXCURSIONS ABOUT A NOMINAL VALUE

a. Perform preliminary operation as stated in paragraph 2-3 or 2-5.
b. Connect voltage to be observed between INPUT and COMMON posts. If one side is grounded, always connect it to the COMMON post. Deflection to the left indicates the voltage being measured is negative; set polarity switch to the negative position in this case. This will cause meter pointer to deflect to the right.
c. Set RANGE switch to lowest range which will give an on-scale meter indication and note nominal value of voltage indicated.
d. Set five voltage readout dials to nominal voltage.
e. Turn NULL switch to lowest position that will allow voltage excursions to remain on scale.
f. Read voltage excursions from meter. Note that full scale right and left meter deflections are equal to the NULL range setting (disregarding 10% over-range at end of scale). Meter deflection to the right indicates that magnitude of voltage under observation has in-

FULL-SCALE DEFLECTION	RANGE SWITCH	NULL SWITCH	VOLTAGE DIALS
1000-0-1000	1000	TVM	No effect
100-0-100	100	TVM	No effect
10-0-10	10	TVM	No effect
1-0-1	1	TVM	No effect
0.1-0-0.1	1	0.1	All zero
0.01-0-0.01	1	0.01	All zero
0.001-0-0.001	1	0.001	All zero
0.0001-0-0.0001	1	0.0001	All zero

Figure 2-3. VTVM RANGES

creased above the nominal value while deflection to the left indicates it has decreased.

2-14. RECORDING VOLTAGE EXCURSIONS

2-15. Recorder output binding posts and an output level control are provided on the 881A and 881AB for monitoring the excursions of an unknown voltage from the voltage indicated by the voltage readout dial settings. If the leakage resistance between the recorder and ground is less than 10,000 megohms, the accuracy of the voltmeter will be impaired. Therefore, the FLUKE Model A88 Isolation Amplifier is recommended for this application. The A88 will allow the use of a wide range of strip chart recorders for recording the voltmeter reading without regard to the input isolation characteristics of the recorder.

2-16. USE OF 881A WITH AN A88 ISOLATION AMPLIFIER AND A RECORDER

2-17. To use the A88 Isolation Amplifier and a recorder with the 881A or 881AB, proceed as follows:

a. Set A88 POWER switch to ON.

b. When batteries are being used as a power source for A88, measure voltage at BATT TEST jacks. If voltage is between 11.7 and 14 volts DC, the batteries are satisfactory for use. However, if battery voltage is below 12.8 volts, batteries are approaching end of their useful life and should be replaced.

c. Connect RECORDER OUTPUT terminals of differential voltmeter to INPUT terminals of isolation amplifier with teflon leads.

d. Connect OUTPUT terminals of isolation amplifier to recorder input terminals.

e. Perform preliminary operation as stated in paragraph 2-3 or 2-5.

f. Short INPUT post to COMMON post and set switches on voltmeter as follows:

RANGE	10
NULL	1
voltage readout dials	1.00000

The meter will indicate full scale (-1.0). This provides up to a maximum of at least 20 millivolts at RECORDER OUTPUT terminals depending on setting of AMP ADJ control.

g. Turn on recorder and set recorder gain so that a recorder input of either ±2 volts or near maximum if maximum is below ±2 volts, will cause recorder deflection desired for full scale deflection of differential voltmeter.

h. Adjust AMP ADJ control on rear of differential voltmeter until recorder deflection obtained is that desired to correspond to full scale deflection of the differential voltmeter.

i. Remove short from INPUT to COMMON post. The voltmeter and recorder are now ready for recording the measurement of voltage excursions about a nominal value. Proceed as instructed under paragraph 2-13.

2-18. USE OF 881A WITH A RECORDER

2-19. To use a recorder with the 881A or 881AB proceed as follows:

a. Connect RECORDER OUTPUT terminals of differential voltmeter to input terminals of recorder with teflon leads.

NOTE

Do not ground either of the voltmeter RECORDER OUTPUT terminals or either of the recorder input terminals. If any of these terminals are grounded, current will be drawn from the Kelvin-Varley divider and the voltmeter will no longer be accurate.

b. Perform preliminary operation as stated in paragraph 2-3 or 2-5.

c. Check for excessive electrical leakage as follows:

(1) Connect a voltage to the input of the 881A and differentially measure its potential in the most sensitive null range.

(2) Alternately connect and disconnect the recorder leads from the output terminals of the 881A while noting the meter needle deflection. More than one major scale division deflection (10% of null range) indicates that excessive leakage has been introduced by the recorder. This will impair the accuracy of the 881A voltmeter.

(3) Disconnect the voltage.

d. Short INPUT post to COMMON post and set switches on voltmeter as follows:

RANGE	10
NULL	1
voltage readout dials	1.00000

The meter will indicate full scale (-1.0). This provides up to a maximum of at least 20 millivolts at RECORDER OUTPUT terminals depending on setting of AMP ADJ control.

e. Adjust AMP ADJ control until recorder deflection obtained is that desired to correspond to full scale deflection of the voltmeter.

f. Remove short from INPUT to COMMON post. The voltmeter and recorder are now ready for recording the measurement of voltage excursions about a nominal value. Proceed as instructed under paragraph 2-13.

2-20. MEASUREMENT OF HIGH RESISTANCE

2-21. One of the important features of the 881A voltmeter is its ability to be used as a megohmmeter for rapid measurements of high resistance from 10 megohms to 11,000 megohms with a typical accuracy of 5%. The following equation may be used to compute the resistance in megohms of an unknown connected to the input bindings posts when the RANGE switch is set to 10.

$$R_x = R_i \left(\frac{E}{E_m} - 1 \right) \text{ megohms}$$

where:

R_x is the unknown resistance in megohms.

E is the voltage indicated by the voltage readout dials.

E_m is the voltage indicated on the meter.

R_i is the input resistance of the TVM circuit in megohms. 10 for the 1 and 0.1 null range and 1 for the 0.01 and 0.001 null range on the 10 volt range.

RANGE OF UNKNOWN RESISTANCE	NULL SWITCH POSITION	TO OBTAIN VALUE OF UNKNOWN IN MEGOHMS WHEN METER INDICATES FULL SCALE
10 megohms to 100 megohms	1	Multiply amount set on voltage readout dials by 10 and subtract 10.
90 megohms to 1090 megohms	0.1	Multiply amount set on voltage readout dials by 100 and subtract 10.
1000 megohms to 11,000 megohms	0.001	Multiply amount set on voltage readout dials by 1000.

Figure 2-4. RESISTANCE MEASUREMENTS

2-22. For rapid measurement of resistance between 10 megohms and 11,000 megohms, proceed as follows:

a. Perform preliminary operation, paragraph 2-3 or 2-5.
b. Set RANGE switch to 10 and NULL switch to 1.
c. Connect unknown resistance between INPUT post and COMMON post. Use short isolated leads to prevent measurement of leakage resistance between leads.
d. Adjust voltage readout dials for full scale meter deflection (-1.0). If full scale deflection cannot be obtained with NULL switch set to 1, set NULL switch to 0.1 or 0.001.
e. Determine value of unknown resistance from figure 2-4.

2-23. NOTES ON USE OF 881A & 881AB

2-24. GROUND LOOP PRECAUTIONS

2-25. Ground loop currents should be avoided to assure accuracy when making measurements. Potential differences are often found at different points on power system grounds. When this is the case, current may flow from the power system ground through the 881A and the equipment under measurement and back to the power system ground. To avoid this when system being measured is grounded, do not connect 881A COMMON binding post to chassis ground post.

2-26. USE OF SHORTING LINK

2-27. A 0.01 uf capacitor (C1) is connected from the COMMON binding post to the chassis ground post to reduce the effect of circulating ac currents from the transformer. In some cases, it is possible for C1 to acquire a charge. For example, C1 will become charged when making common mode voltage measurements. This condition may cause an error on low level measurements (under 5 volts) due to C1 discharging through the Kelvin-Varley divider and leakage resistance to ground. Connecting the shorting link from the COMMON post to the ground post for a few seconds will discharge C1 and thus prevent an inaccurate indication.

2-28. EFFECT OF AC COMPONENTS

2-29. An ac component of several times the unknown dc may be present on the unknown and the 881A will always indicate well within the specifications for frequencies over a few hundred cycles. An ac component may have an adverse effect if it is of a low frequency or if it has a frequency that is a multiple or submultiple of the chopper frequency. A triple section low pass filter (R201, C201, R202, C202, R203, and C203) is used at the input of the null detector to reduce any ac present on the dc being measured. At lower frequencies, this low pass filter is less effective and the magnitude of the ac component is more significant. If this frequency is below 100 cycles, the accuracy may no longer be with specifications. For example, a 60 cycle ac voltage that is 1% of the input will cause an error of approximately 0.001% which is well within the specifications. This 1000:1 rejection of ac also applies until the ac voltage is 1000 times the null range. For example, on the .01 volt null range, the ac rejection of 1000:1 applies up to 10 vac. When the frequency is very close to a multiple or submultiple of the chopper frequency (approximately 83 cycles), the meter needle will oscillate at the difference frequency. If ac components that affect the accuracy are ever encountered, additional filtering will be required. For an ac of a single frequency, a twin-T filter is effective and has the advantage of low total series resistance. For an ac variable frequency, an ordinary low pass filter may be used. In either case, high quality capacitors of high leakage resistance should be used.

2-30. EFFECT OF A DC COMMON MODE VOLTAGE

2-31. DC common mode errors are caused by leakage currents passing through ground loops. Since great care has been taken in the design and construction to insulate the circuitry from chassis ground, accurate dc common mode measurements up to 1000 volts dc above ground can be made with the 881A and 881AB. The dc common mode rejection is at least 134 db (5,000,000 to 1) or 0.2 uv error per common-mode-volt all the way up to 70% relative humidity. However, since the leakage resistance is dependent on dampness, the dc common mode error is typically much less at lower relative humidities. Thus, common mode measurements should be made with a relative humidity below 70%. Also, if the common mode voltage is greater than 50 volts, the measurement should be made several minutes after hookup for best accuracy. This is due to the time it takes to charge stray capacities to ground through the extremely high leakage resistances.

2-32. BATTERY CHECKING

2-33. If the voltmeter is left in the battery operating mode for an extended period of time, the batteries will become discharged. When the batteries are left in a

completely discharged state with the voltmeter turned off, their voltage will recover with time. It is possible that the batteries may have recovered enough for the meter to indicate they are charged when the power switch is first set to battery check. However, after a few seconds, the battery voltage will fall and the meter will indicate that the batteries need to be charged. It should also be noted that the voltage characteristic of the nickel-cadmium batteries is very flat except near full charge and complete discharge. Therefore, when the batteries are checked, the meter needle deflection will not be proportional to the remaining ampere-hour capacity of the batteries. Just after the batteries are charged, the meter needle will indicate near full scale. However, most of the time the batteries are charged, the meter needle will indicate near half scale. A few hours before the batteries need a recharge, the meter needle will indicate just within the battery ok region.

2-34. MEASUREMENT OF NEGATIVE VOLTAGES

2-35. Because of a polarity switch, voltage which are negative with respect to ground as well as the more commonly encountered positive voltages may be measured with equal facility. If the INPUT post is connected to the metal case, either at the 881A or at the source under measurement, the accuracy of the voltmeter may be reduced. However, with the polarity switch, the INPUT post never has to be connected to ground. If the unknown voltage is grounded, always connect the grounded side to the COMMON post and use the polarity switch to obtain the proper result.

SECTION III

THEORY OF OPERATION

3-1. INTRODUCTION

3-2. Figure 3-1 shows the block diagram for the 881A Differential Voltmeter. As seen in this figure, the circuit is mainly composed of an input attenuator, a dc transistorized voltmeter (tvm), and an extremely accurate 0 to 11 volt reference. The input attenuator reduces the input voltage by a factor of the 100 on the 1000 and 100 volt range. The tvm uses a null detector, an attenuator, and a meter to obtain high sensitivity. The 0 to 11 volt reference uses a range divider and a Kelvin-Varley attenuator to make the output of two well regulated zener diodes adjustable. Refer to the functional schematic following Section VI for more detail. This schematic is designed to aid in the understanding of circuit theory and troubleshooting. The signal flow is from left to right and the components are laid out in a functionally logical manner.

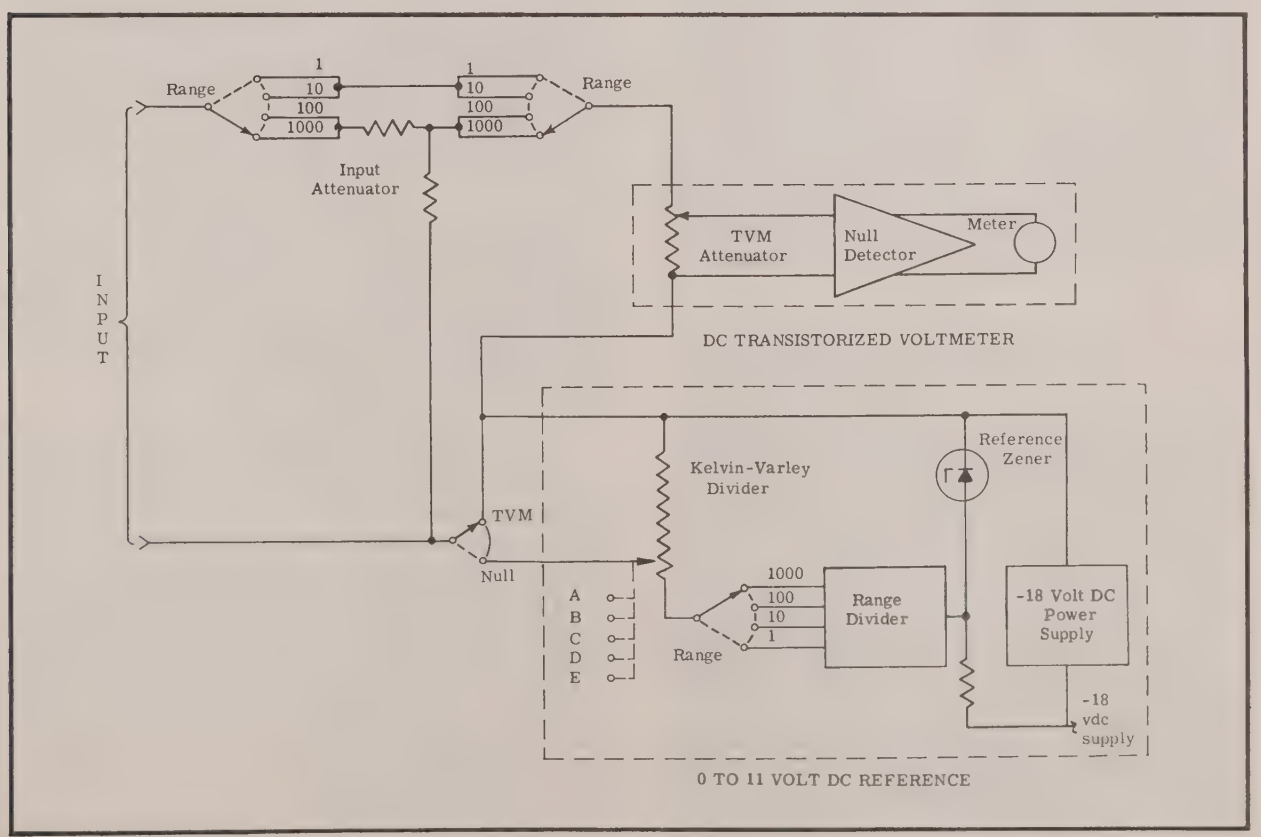


Figure 3-1. 881A DIFFERENTIAL VOLTMETER BLOCK DIAGRAM

3-3. The overall operation of the voltmeter may be summarized as follows. To measure the approximate value of a dc voltage between 0 and 11 volts, the unknown voltage is connected directly across the tvm attenuator. This attenuator is set in such a way that the maximum voltage for each range is reduced to a signal of 1 millivolt (100 microvolts for the 1 volt range in the highest null mode). The signal is then applied to the null detector and causes 100 microampers to flow through the meter for full scale deflection. To accurately measure this dc voltage, the unknown voltage is connected across the series combination of the tvm and the 0 to 11 volt reference. The reference voltage is then adjusted with the five voltage readout dials until it matches the unknown voltage as indicated by the tvm. For voltages between 11 and 1100 volts, the input attenuator divides the unknown voltage by 100. The 881A then operates essentially the same as for measurements from 0 to 11 volts.

3-4. In order to provide for a more complete understanding of the 881A voltmeter, the following paragraphs describe each section of the circuit in detail.

3-5. INPUT ATTENUATOR

3-6. Since the instrument contains a 0 to 11 volt reference, the unknown voltage is measured by comparing it to a known voltage with the aid of a null detector only on the 1 and 10 volt range. On the 100 and 1000 volt range, the input attenuator (R100 through R104) divides the unknown voltage by 100 and this attenuated voltage is then measured by the potentiometric principal. Thus, after attenuation by 100, the 100 and 1000 volt ranges are reduced to the equivalent of 1 and 10 volt ranges. The input attenuator is extremely accurate and has excellant long term stability. The 10K variable resistor (R103) is used during factory calibration to setup the proper division ratio. This adjustment can then be performed as required at regular calibration intervals.

3-7. DC TRANSISTORIZED VOLTMETER

3-8. GENERAL

3-9. The dc tvm is composed of an attenuator, a null detector, and meter. The heart of the dc tvm is the null detector in which the dc signal is modulated by an electromechanical chopper, amplified by a five stage resistance-capacitance coupled amplifier, rectified by a transistor switch, and finally filtered to produce a dc output. The null detector has a high amount of negative current feedback. This makes the proportion of the output current feedback approximately equal to the signal voltage divided by the resistance of the feedback resistor, regardless of the amplifier characteristics. The high negative feedback also makes the amplifier relatively insensitive to the gain changes in individual transistors due to aging, and replacement. The output current from the null detector is indicated on a meter that has tautband suspension. This suspension does away with all friction associated with meter pivot stickiness. Thus, any tendency for the meter pointer to stick at one point of the scale and then jump to another point is eliminated. The tvm attenuator is used to reduce the voltage span of each range to a common range usable by the null detector to produce proper meter deflection.

3-10. NULL DETECTOR

3-11. The null detector is a current feedback amplifier that drives a meter. Any feedback amplifier is essentially a null seeking device. That is, it tends to make the voltage fed back to the input equal to the input voltage. In a current feedback amplifier, the feedback voltage is equal to the voltage drop across a fixed resistor caused by the output current or a portion of the output current. At the input to the 881A null detector R201, C201, R202, C202, R203, and C203 form a triple section low pass filter that reduces any ac component present on the dc voltage being measured. The difference between the voltage appearing at the output of the filter and the voltage developed across feedback resistor R236 is converted to an alternating voltage by G201, an 84 cycle chopper. The voltage across R236 is proportional to the current flowing in the meter. The alternating voltage created by G201 is amplified by a five-stage solid-state amplifier. The first stage is a p-channel field effect transistor (Q201). The field effect transistor provides both high impedance and low noise input characteristics. The next four stages consist of two transistor doubletons (Q202 to Q205). During one portion of the chopper cycle, the output of the amplifier is clamped to approximately null detector common potential by Q206, a transistor switch. The transistor switch is gated in synchronization with the chopper since the gating pulse comes from the voltage that is used to drive the chopper. During the other portion of the chopper cycle, the output of the amplifier is filtered by R-C filter R225-C219 to provide a dc current for the meter. A portion of the current that flows through the meter is shunted back to the 200Ω feedback resistor R236 thus completing the feedback loop. The null detector has a basic sensitivity of 1 millivolt except in the most sensitive null mode for the 1 and 100 volt range where the sensitivity is 100 microvolts. For the two most sensitive null modes in the 100 and 1000 volt range, the sensitivity is boosted 10% to compensate for the loading effect of the tvm DC attenuator on the input attenuator. The output resistance of the input attenuator is 100K and the input resistance of the tvm dc attenuator is 1 meg. Thus, when monitoring voltage excursions, much more accurate off null readings are obtained due to the 10% boost in null sensitivity.

3-12. TVM ATTENUATOR

3-13. In the tvm mode, two positions on the tvm attenuator selected by range switch section S2D provide the necessary reduction of the 1 and 10 volt ranges for proper null detector input. The same two positions on the tvm attenuator are used for the 100 and 1000 volt ranges because the input attenuator divides the input signal by 100 and thus reduces the 100 and 1000 volt ranges to the equivalent of 1 and 10 volt ranges. In the differential mode, the voltage difference (unknown voltage, or unknown voltage divided by 100, minus reference voltage) is reduced as necessary by positions on the tvm attenuator selected by null switch sections S3H, S3G, and S3E to provide the basic null detector inputs of 1 millivolt or 100 microvolts.

3-14. INPUT RESISTANCE

3-15. For the tvm, low sensitivity, and medium low sensitivity modes, the input resistance of the tvm attenu-

ator is 10 megohms (R2 through R7). For the medium high and high sensitivity modes, the input resistance of the tvm attenuator is 1 megohm (R4 through R7). However, this is not the input resistance of the 881A. For the 1 and 10 volt range, the input resistance is determined by dividing the unknown terminal voltage by the current drawn from the unknown. The current drawn from the unknown is equal to the difference between the unknown terminal voltage and the internally known voltage divided by the resistance of the tvm attenuator. The equation for input resistance can therefore be written as:

$$R_{in} = \frac{E_u}{I_u} = \frac{E_u R_a}{|E_u - E|} = \frac{E_s (R_a + R_s)}{|E_s - E|} - R_s$$

where:

R_{in} = input resistance of voltmeter

E_u = $E_s - I_u R_s$ = terminal voltage of unknown

I_u = current drawn from unknown

E_s = source voltage of unknown

R_s = source resistance of unknown

R_a = input resistance of tvm attenuator

E = voltage indicated by voltage readout dials

$| \; |$ = absolute value (magnitude only)

Thus, the input resistance is essentially infinite (leakage resistance across input is in the order of 10^{12} ohms) at null when E is equal to E_u and E_s. For the 100 and 1000 volt range, the input attenuator is always connected across the input terminals. Thus, the input resistance is equal to the resistance of the input attenuator which is 10 megohms.

3-16. CHOPPER DRIVE CIRCUIT

3-17. The chopper drive circuit determines the chopper timing frequency of 85 cps. The circuit is symmetrical with the transistors biased so that they can conduct simultaneously. However, cross-coupling capacitors C105 and C106 force Q106-Q109 and Q107-Q108 to conduct alternately. This results in a square wave varying from about 0 to 6 volts that drives chopper coil G201. The symmetry and frequency of the waveform are adjusted with R125 and R123, respectively.

3-18. NULL DETECTOR POWER SUPPLY

3-19. The voltage for null detector amplifier stages Q201 through Q205 is supplied by the same -18 volt power supply that is used to power the 0 to 11 volt reference. The voltage for chopper drive circuit transistors Q106 through Q109 is obtained from a half-wave rectifier consisting of diode CR101 and an R-C filter network (R105 and C101) that supplies 6 volts dc. Current determining resistors R238 and R240, diodes CR201 and CR202, and divider resistor R239 provide a compensating voltage for the purpose of adjusting the null detector to zero with R239 when there is no signal input. Diode CR201 keeps one side of R239 at approximately +0.6 volt dc with respect to the null detector common while diode CR202 keeps the other side at approximately -0.6 volt dc.

3-20. EFFECT OF AC COMPONENTS

3-21. The only ac voltage component that will reduce the accuracy of the 881A is one that either saturates the null detector or one that beats with the chopper frequency. Since the voltage required for saturation is greater than that required for beating, the null detector is most sensitive to an ac component with a frequency that is a submultiple or a low multiple of the chopper frequency. However, this is easy to detect because the meter will beat at the difference frequency. The low pass filter at the input of the chopper-amplifier will attenuate any ac component. The magnitude of the ac voltage appearing at the output of the filter depends on both its amplitude and frequency before filtering. For all practical purposes, one should never encounter any trouble above a hundred cycles. Below this, the filter may not attenuate the ac component enough. However, this is not as bad as it appears. A 60 cycle ac voltage that is 1% of the input voltage will cause an error of approximately 0.001% which is well within specifications. If ac components that affect accuracy are ever encountered, additional filtering as set forth in the operating instructions will eliminate the problem.

3-22. TVM GAIN AND ZERO ADJUSTMENTS

3-23. Variable resistor R239 in the feedback network provides a means of adjusting the output current of the null detector to zero when there is no input signal. The gain of the null detector is adjusted by means of R230 in the feedback network for the 1 millivolt sensitivity and by means of R231 for the 100 microvolt sensitivity.

3-24. RECORDER OUTPUT

3-25. The recorder output is picked off divider string R226, R10, and R227. Recorder output AMP ADJ control R10 provides a means of adjusting the output voltage up to a maximum of at least 20 millivolts at full scale deflection (disregarding 10% over-range at end of scale). The voltage at the RECORDER OUTPUT terminals is proportional to the meter reading.

3-26. 0 TO 11 VOLT REFERENCE

3-27. GENERAL

3-28. When the 881A is used to make differential voltage measurements between 0 and 11 volts, an internal voltage is nulled or matched against the unknown voltage. An extremely accurate reference is therefore required. This is obtained from the 0 to 11 volt reference. The 0 to 11 volt reference is composed of a well regulated -18 volt power supply, a range divider, and a five decade Kelvin-Varley divider. The range divider reduces the voltage from a pair of stable Zener diodes in the -18 volt reference supply to 11 volts for the 10 and 1000 volt ranges and to 1.1 volts for the 1 and 100 volt ranges before it is applied to the Kelvin-Varley divider. The Kelvin-Varley divider divides its input voltage (11 or 1.1 volts) into over 1,100,000 equal increments any number of which may be selected by setting the five decades with the five voltage readout dials. The output of the Kelvin-Varley divider, therefore, provides an extremely accurate reference voltage.

3-29. -18 VOLT POWER SUPPLY

3-30. The -18 volt power supply uses a diode (CR102) and a filter network (R106 and C102) to supply unregulated dc voltage to series passing transistor Q101. In the Model 881AB, unregulated dc is supplied directly from a set of two batteries (BT3) in the BAT CHECK and BAT OPR modes. The voltage is regulated by comparing a sample of the output voltage tapped off a divider string (R108, R109, and R110) with the voltage from Zener reference diodes CR103 and CR104 in differential amplifier Q102 - Q103. The output of Q102 - Q103 is fed to differential amplifier Q104 - Q105 which drives the base of series pass transistor Q101. The control action of the differential amplifiers continuously adjusts the voltage drop across the series pass transistor so as to keep the sample voltage equal to the voltage of the Zener reference diodes. Any difference in voltage, the error, is amplified by Q102 - Q103 and Q104 - Q105 and thus changes the voltage drop across Q101 to maintain the output at -18 volts. The -18 volt output is used to provide operating voltages for the null detector and, with the aid of current determining resistors R115 and R116, to supply an extremely constant current to its own Zener reference diodes CR103 and CR104. The voltage across the two Zener diodes may be anywhere between approximately 11.4 and 13 volts. However, this voltage has a stability of better than ±15 ppm per year and an overall temperature coefficient of less than 2 ppm per °C.

3-31. RANGE DIVIDER

3-32. In the 1000 and 10 volt range, the Zener reference diode voltage is connected directly to the Kelvin-Varley divider through resistors R118 and R119 by means of range switch sections S2F and S2E. The voltage drop across R118 and R119 reduces the Zener reference voltage to 11 volts at the input of the Kelvin-Varley divider. In the 100 and 1 volt range, range resistors (R120, R121, and R122) selected by range switch sections S2F and S2E reduce the voltage to 1.1 volts at the input to the Kelvin-Varley divider.

3-33. KELVIN-VARLEY DIVIDER

3-34. The five Kelvin-Varley decades composed of resistors R12 and R302 to R364, and associated voltage dials A through E provide a means of making the two precision voltages (11 and 1.1 volts) adjustable. The first decade has twelve 5K resistors (a 4,999.2 ohm resistor and a 2 ohm trimmer). Two of these resistors are shunted by the 10K total resistance of the second decade. Between the two wipers of S5 (voltage dial A) then, there is a total resistance of 5K (10K paralleled by 10K). Thus, the first decade divides the voltage across it into eleven equal parts with one of the equal parts appearing across the two shunted resistors. Similarly, the second, third, and fourth decades divide the voltage across them into ten equal parts. Note that the second, third, and fourth decades each have eleven 1K resistors. The resistors may have the same value because padding resistors R328 - R329 and R315 - R316 are used across the third and fourth decades respectively to keep the proper resistance matching. The last decade, with its associated shunt resistors to keep the proper matching, is a variable resistor which can be set to pick off increments equal to less than 1/100 times the voltage across its input. The Kelvin-Varley resistors are matched for both temperature coefficient and tolerance thus providing an overall accuracy of 0.002% absolute from 1/11 of full scale to full scale. With the null switch in any null range, the output of the Kelvin-Varley divider is connected in series with the tvm attenuator thus providing the accurate 0 to 11 volt or 0 to 1.1 volt reference voltage required.

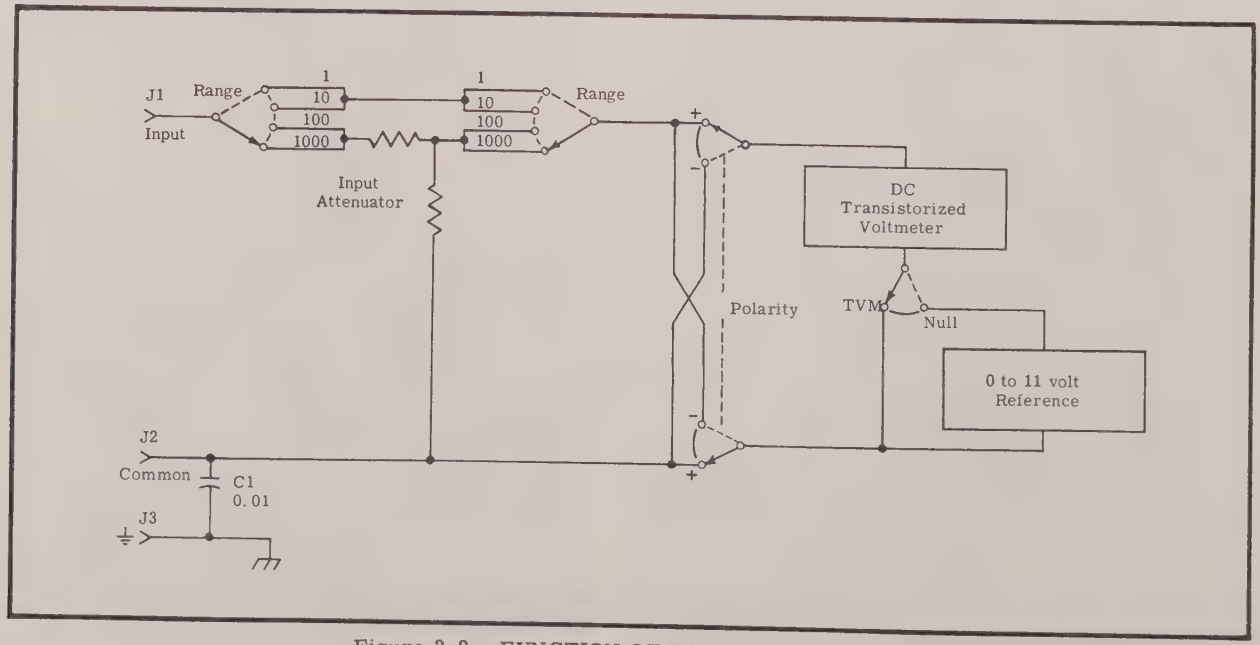


Figure 3-2. FUNCTION OF POLARITY SWITCH

3-35. ADJUSTMENTS

3-36. Variable resistor R110 is used during final factory calibration to set the reference supply to -18 volts. This adjustment is not exceedingly critical and should have to be done only when a component of the reference supply has been replaced. The voltage from the Zener reference diodes is reduced to 11 volts at the input to the Kelvin-Varley divider by adjusting variable resistor R119 during calibration. Range-divider variable resistor R121 may then be adjusted for 1.1 volts at the input to the Kelvin-Varley divider. The 2 ohm trimmer resistors (even resistors from R342 to R364) and variable padding resistors R329, R316, and R303 should require adjustment only after a component of the Kelvin-Varley divider has been replaced.

3-37. POLARITY SWITCH

3-38. The polarity switch S4, as seen in figure 3-2, reverses the transistorized voltmeter - reference voltage combination with respect to the input. Note that a 0.01 uf capacitor (C1) is connected from the COMMON post to the chassis ground post to reduce the effect of ac circulating currents. If the instrument did not contain a polarity switch, the grounded side of any unknown voltage that is negative with respect to ground would have to be connected to the INPUT post. This would ground the INPUT post and effectively place C1 across the input. With this capacitance connected across the circuit being measured several problems would arise. The polarity switch provides equal convenience in measuring positive and negative voltages without the occurance of these problems.

SECTION IV

MAINTENANCE

4-1. INTRODUCTION

4-2. The 881A DC Differential Voltmeter seldom requires any maintenance. Without extreme abuse, all that should be required is periodic cleaning and calibration as specified in this section. However, to determine if the instrument is within specifications, it is recommended that its performance be checked just before calibration by using the performance checks given in this section. If a problem arises, the information on corrective maintenance in this section will be extremely useful.

4-3. TEST EQUIPMENT

4-4. Figure 4-1 lists the recommended equipment and specifications required for performance checking, calibration, and corrective maintenance. If the recommended equipment is not available, other equipment which meets the required specifications may be used.

NOMENCLATURE	SPECIFICATIONS REQUIRED	RECOMMENDED INSTRUMENT	USED FOR	PARA
VTVM	Range: 0 to 40 vdc, 0 to 300 vac Accuracy: ±3% dc, ±5% ac Input Impedance: 10MΩ, 5 pf dc 1MΩ, 100 pf ac	RCA Voltohmyst	CORRECTIVE MAINTENANCE -Voltage Level Checking -Reference Voltage Regulation check -Null Detector Input Stage Bias Adjustment	 4-30 4-33 4-40
Autotransformer	103 to 127 volts (207 to 253 volts for 230 volts nominal line instruments)	General Radio Model W5MT3 Variac (W5HMT for 230 volts nominal line instruments)	CORRECTIVE MAINTENANCE -Reference Voltage Regulation Check	 4-33
DC Differential Voltmeter	Range: 10 to 20 vdc Accuracy: 0.05% Null Range: At least 10 mv.	Almost any FLUKE Differential Voltmeter	CORRECTIVE MAINTENANCE -Reference Voltage Regulation Check -Negative 18 Volt Supply Adjustment	 4-33 4-38
Standard Cell Bank	Accuracy: ±0.0005%	Guildline Instruments Model 9152/P4	PERFORMANCE CHECKING -Differential Measurement Check CALIBRATION -Preliminary Calibration CORRECTIVE MAINTENANCE -Common Mode Measurement Check	 4-13 4-19 4-34

Figure 4-1. TEST EQUIPMENT REQUIREMENTS (sheet 1 of 2)

NOMEN-CLATURE	SPECIFICATIONS REQUIRED	RECOMMENDED INSTRUMENT	USED FOR	PARA
Power Supply	Voltage: 1 to 1100 vdc Current: 0 to 2 ma Stability: ±0.005% per hour Resolution: 5 mv	FLUKE Model 412B	PERFORMANCE CHECKING -Differential Measurement Check CALIBRATION -Preliminary Calibration CORRECTIVE MAINTENANCE -Common Mode Measurement Check -Kelvin-Varley Divider Check -Kelvin-Varley Divider Adjustment	 4-13 4-19 4-34 4-35 4-41
Null Detector	Range: 1 uv to 1 mv end scale	FLUKE Model 845A	PERFORMANCE CHECKING -Differential Measurement Check CALIBRATION -Preliminary Calibration CORRECTIVE MAINTENANCE -Kelvin-Varley Divider Check -Kelvin-Varley Divider Adjustment	 4-13 4-19 4-35 4-41
Kelvin-Varley Divider	Number of Decades: Seven Input Resistance: 100K Ratio Accuracy: 1 ppm from 1/10 of full scale to full scale	FLUKE Model 720A	PERFORMANCE CHECKING -Differential Measurement Check CORRECTIVE MAINTENANCE -Kelvin-Varley Divider Check -Kelvin-Varley Divider Adjustment	 4-13 4-35 4-41
Lead Compensator	Resolution: 10 mΩ Divider Resistance Ratios: From 1:1 to 10:1	FLUKE Model 721A	CORRECTIVE MAINTENANCE -Kelvin-Varley Divider Check -Kelvin-Varley Divider Adjustment	 4-35 4-41
Voltage Reference Divider	Input Voltage: 10, 100, 1000 vdc Output Voltage: 1, 10, 100, 1000 vdc Accuracy: ±0.001% + 2 uv Divider Current Adjustment Range: To a minimum of 1 ppm and a maximum of 5 ppm on all ranges	FLUKE Model 750A	PERFORMANCE CHECKING -Differential Measurement Check CALIBRATION -Preliminary Calibration	 4-13 4-19
Oscilloscope	Sweep Range: 1 msec/cm to 10 msec/cm Sensitivity: 2 v/cm	Hewlett Packard Model 120B	CORRECTIVE MAINTENANCE -Chopper Drive Circuit Adjustment	 4-39

Figure 4-1. TEST EQUIPMENT REQUIREMENTS (sheet 2 of 2)

4-5. PERIODIC MAINTENANCE

4-6. Periodic maintenance consists primarily of occasional cleaning to remove dust, grease, and other types of contamination. However, since the 881A is a completely enclosed unit, the need for occasional cleaning is greatly reduced. Special care has been taken to prevent leakage across critical switch wafers, areas of some printed circuit boards, and from the printed circuit boards to chassis ground. The power, range, null, polarity, and all voltage readout dial switches are vacuum impregnated with Dow Corning silicone oil. These switches are also isolated from the front panel with Lexan spacers. The printed circuit boards are coated with Epocast 8267. Also, the printed circuit boards are isolated from chassis ground by means of polyethelene grommets.

4-7. To prevent excessive electrical leakage, proceed as follows:

CAUTION

Avoid touching polyethelene grommets. The grease on the hands of some people can cause excessive electrical leakage.

a. Blow instrument out with low-pressure, clean, dry air to remove most accumulations of dust and foreign matter. Pay particular attention to the input binding posts, binding post wiring, switches, and polyethelene grommets which insulate printed circuit boards from chassis.

b. Clean polyethelene grommets, binding posts, and front panel with anhydrous denatured ethyl alcohol or a pressure can of Freon TF Degreaser (Miller-Stephenson Chemical Co., Inc.) and, when necessary, a clean cloth or a cotton swab.

CAUTION

Do not use Metriclene, acetone, laquer thinner, or any other methyl ethyl ketones, since they will react with the Lexan rotor on the CTS plastic switches. Also, be careful not to saturate the switch contacts which have been lubricated for life.

c. When necessary, clean all exposed dielectric surfaces of switches with denatured alcohol using a small, stiff-bristled brush which has been wrapped with a clean cloth to prevent saturating the switch contacts.

d. After cleaning, recoat exposed switch insulating material with a solution of Dow Corning 200 having a viscosity between 5 and 20 centistokes. This prevents leakage due to moisture on these surfaces.

4-8. PERFORMANCE CHECKING

4-9. GENERAL

4-10. The following performance checks are designed to check the instruments performance against the specifications. As such, they may be used as a routine maintenance procedure and as an incoming inspection procedure. They should be accomplished under typical laboratory conditions in a draft free area with an ambient temperature of 72.5 (±2.5)°F. It is recommended that these performance checks be done just before calibration of the instrument. When used in this way, the performance checks yield a valuable case history on the characteristics of each individual instrument. Just prior to calibration, the instrument should be within specifications. If the instrument is out of specifications, the error should not be calibrated out of the instrument. The correct procedure is to find the reason why and then eliminate it. Localizing the problem to a particular area of the instrument may be done by an analysis of the performance check results.

4-11. NULL DETECTOR CHECK

4-12. The null detector is checked in this procedure by using the reference supply and Kelvin-Varley divider. This is possible because the reference supply and Kelvin-Varley divider are a few hundred times more accurate than the null detector. If the instrument fails to pass this check, there is a remote chance that the cause is due to a faulty reference supply or Kelvin-Varley divider. In this case, the measurement of an appropriate voltage in the TVM mode will indicate if the null detector is operating properly. Proceed as follows:

a. Set 881A meter to zero with mechanical zero control.

b. Set POWER switch to LINE OP with 881AB or to ON with 881A and allow a warmup period of 5 minutes.

c. Short INPUT post to COMMON post.

d. Set ac-dc switch to + (positive).

e. Set switches on voltmeter as shown in figure 4-2. Meter should indicate within 1-1/2 small scale divisions (±3% of null range) of value shown in figure 4-2.

f. Remove short from between INPUT and COMMON posts and set POWER switch to OFF.

VOLTMETER SWITCH SETTINGS			
RANGE	NULL	VOLTAGE READOUT DIALS A B C D E	METER INDICATION
10	1.0	1.0 0 0 00	-1.0
10	.1	0.1 0 0 00	-1.0
10	.01	0.0 1 0 00	-1.0
10	.001	0.0 0 1 00	-1.0
1	.1	.1 0 0 0 00	-1.0
1	.01	.0 1 0 0 00	-1.0
1	.001	.0 0 1 0 00	-1.0
Before proceeding, set RANGE switch to 1, NULL switch to .0001, all voltage readout to zero, and null meter by adjusting electronic ZERO control.			
1	.0001	.0 0 0 1 00	-1.0
100	10	1 0.0 0 00	-1.0
100	1	0 1.0 0 00	-1.0
100	.1	0 0.1 0 00	-1.0
100	.01	0 0.0 1 00	-1.0
1000	100	1 0 0.0 00	-1.0
1000	10	0 1 0.0 00	-1.0
1000	1	0 0 1.0 00	-1.0
1000	.1	0 0 0.1 00	-1.0
10	1	0.1 0 0 00	-0.1
10	1	0.2 0 0 00	-0.2
10	1	0.3 0 0 00	-0.3
10	1	0.4 0 0 00	-0.4
10	1	0.5 0 0 00	-0.5
10	1	0.6 0 0 00	-0.6
10	1	0.7 0 0 00	-0.7
10	1	0.8 0 0 00	-0.8
10	1	0.9 0 0 00	-0.9
10	1	1.0 0 0 00	-1.0
10	1	1.1 0 0 00	-1.1

Figure 4-2. SETTINGS FOR NULL DETECTOR CHECK

4-13. DIFFERENTIAL MEASUREMENT CHECK.

4-14. The following procedure checks the accuracy of the instrument with full input on each range and also with each voltage readout dial set to 1, then to 2, 3, 4, 5, 6, 7, 8, and 9 on the 10 volt range. This method allows the accuracy to be checked with a minimum number of measurements. Proceed as follows:

a. Set meter to zero with mechanical zero control.
b. Set POWER switch to LINE OP with 881AB or to ON with 881A and allow voltmeter to warmup to equilibrium temperature (about 5 minutes).
c. Set up the necessary equipment to provide dc voltages of 1, 10, 100, and 1000 volts with an accuracy of ±(0.0015% + 2 uv). Proceed as follows:
(1) Connect equipment as shown in figure 4-3.

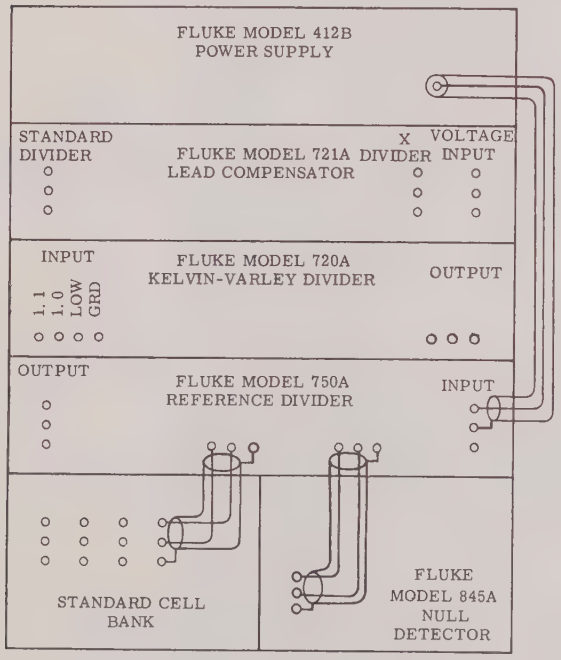


Figure 4-3. DIFFERENTIAL MEASUREMENT CHECK AND CALIBRATION SETUP

CAUTION

Make sure HIGH VOLTAGE switch on 412B Power Supply is set to off.

(2) Turn on all equipment and allow it to warmup to equilibrium temperature (about 1/2 hour).
(3) Set STANDARD CELL VOLTAGE switches on 750A Reference Divider to voltage of standard cell.
(4) Set INPUT switch on 750A Reference Divider to 1000 volts.
(5) Set voltage dials on 412B Power Supply to 1000 volts.
(6) Set HIGH VOLTAGE switch on 412B Power Supply to ON.
(7) Set 845A Null Detector to 100 MICROVOLTS.
(8) Adjust voltage dials on 412B Power Supply and COARSE and FINE dials on 750A Reference Divider for a null in each successively more sensitive null range on 845A Null Detector. The null detector should be zeroed as necessary.
(9) Voltages of 1, 10, 100, and 1000 volts dc are available at the OUTPUT terminals when the OUTPUT switch is set to the 1, 10, 100, and 1000 volt positions respectively. Note that COARSE and FINE dials on 750A Reference Divider and possibly voltage dials on 412B Power Supply may have to be adjusted to maintain a null on 845A Null Detector due to drifting or loading of the reference divider.

d. Connect 881A ground post to line ground.
e. Short INPUT post to COMMON post.
f. Set 881A RANGE switch to 1, NULL switch to .0001, and all voltage readout dials to 0 (zero).
g. Null meter by adjusting electronic ZERO control (R239).
h. Remove short from between INPUT and COMMON posts.
i. Set 881A NULL switch to 0.1 and voltage readout dials to 1.000000.
j. Apply 1 volt dc ±(0.0015% + 2 uv) between INPUT and COMMON posts.
k. Adjust voltage readout dials for zero meter deflection in each successively more sensitive null range. Final voltage readout dial setting should be between .999950 and 1.000050.
l. Set 881A RANGE switch to 10, NULL switch to 1, and voltage readout dials to 10.00000.
m. Apply 10 volts dc ± 0.0015% between INPUT and COMMON posts.
n. Adjust voltage readout dials for zero meter deflection in each successively more sensitive null range. Final voltage readout dial setting should be between 9.99950 and 10.00050.
o. Set 881A RANGE switch to 100, NULL switch to 10, and voltage readout dials to 100.0000.
p. Apply 100 volts dc ± 0.0015% between INPUT and COMMON posts. Note that voltage dials on 412B Power Supply and COARSE and FINE dials on 750A Reference Divider must be readjusted for a null on 845A Null Detector due to loading of voltmeter on 750A Reference Divider.
q. Adjust voltage readout dials for zero meter deflection in each successively more sensitive null range. Final voltage readout dial setting should be between 99.9950 and 100.0050.
r. Set 881A RANGE switch to 1000, NULL switch to 100, and voltage readout dials to 1000.000.
s. Apply 1000 volts dc ± 0.0015% between INPUT and COMMON posts. Note that voltage dials on 412B Power Supply and COARSE and FINE dials on 750A Reference Divider must be readjusted for a null on 845A Null Detector because the voltmeter no longer loads 750A Reference Divider.
t. Adjust voltage readout dials for zero meter deflection in each successively more sensitive null range. Final voltage readout dial setting should be between 999.950 and 1000.050.

u. Set up the necessary equipment to provide voltage of 1.111111, 2.222222, ..., 9.999999 volts dc with an accuracy of ±(0.0015% + 2 uv). Proceed as follows:
(1) Set HIGH VOLTAGE switch to off on 412B Power Supply.

(2) Reconnect OUTPUT of 750A Reference Divider to INPUT of 720A Kelvin-Varley Divider as shown in figure 4-4.

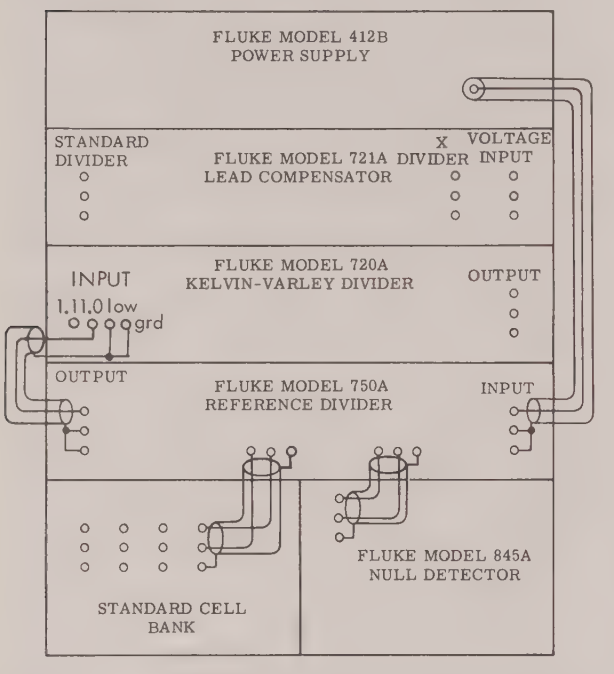


Figure 4-4. REFERENCE SUPPLY AND EXTERNAL KELVIN-VARLEY DIVIDER CHECK SETUP

(3) Set voltage dials to 10 volts on 412B Power Supply.
(4) Set INPUT switch and OUTPUT switch on 750A Reference Divider to 10 volts.
(5) Set HIGH VOLTAGE switch to ON on 412B Power Supply.
(6) Set 845A Null Detector to 100 MICROVOLTS.
(7) Adjust voltage dials on 412B Power Supply and COARSE and FINE dials on 750A Reference Divider for a null in each successively more sensitive null range on 845A Null Detector. The null detector should be zeroed as necessary.
(8) Voltages of 1.111111, 2.222222, ...,9.999999 volts dc are available at the OUTPUT terminals of 720A Kelvin-Varley Divider when all voltage dials are set to 1, 2, ...,9 respectively.
v. Set RANGE switch to 10 and NULL switch to .001 on 881A.
w. Apply voltages listed in figure 4-5 between INPUT and COMMON posts of 881A, set voltage readout dials on 881A as indicated for applied voltage, and adjust voltage readout dials for a null on 881A meter. Final voltage readout dial settings should be within the values listed in figure 4-5.

4-15. CALIBRATION

4-16. GENERAL

4-17. The 881A should be calibrated as often as deemed necessary. However, it is recommended that the instrument be calibrated every six months under ordinary laboratory conditions. For special applications where extreme accuracy is required, it may be desired to calibrate the instrument more frequently. Calibration should be accomplished under typical laboratory conditions in a draft free area with an ambient temperature of 72.5 (±2.5)°F for maximum accuracy.

VOLTAGES APPLIED TO 881A	INITIAL VOLTAGE READOUT DIAL SETTING	FINAL VOLTAGE READOUT DIAL SETTING
1.111111	1.11111	1.11103 to 1.11119
2.222222	2.22222	2.22209 to 2.22236
3.333333	3.33333	3.33314 to 3.33353
4.444444	4.44444	4.44420 to 4.44469
5.555555	5.55555	5.55525 to 5.55586
6.666666	6.66666	6.66631 to 6.66702
7.777777	7.77777	7.77736 to 7.77819
8.888888	8.88888	8.88842 to 8.88936
9.999999	9.99999	9.99947 to 10.00052

Figure 4-5. VOLTAGE READOUT DIAL LIMITS

4-18. For convenience, the calibration procedure is divided into five parts: Preliminary Calibration, Null Detector Calibration, 10 Volt Range Calibration, 1 Volt Range Calibration, and 100 & 1000 Volt Range Calibration. Calibration is normally done by performing all five parts in the sequence given here. However, the calibration procedure is written so that any section may be calibrated by performing the calibration procedure for that section after performing Preliminary Calibration. The recommended equipment and the specification required for calibration are shown in figure 4-1. All controls may be located with the aid of figure 4-6.

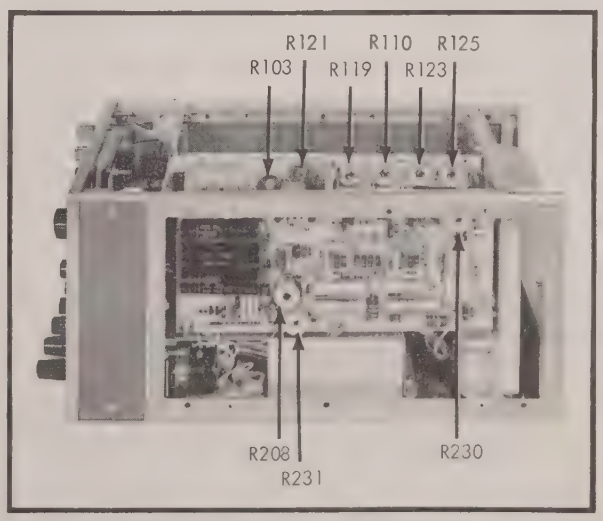


Figure 4-6. ADJUSTMENT LOCATIONS

4-19. PRELIMINARY CALIBRATION

a. Set meter to zero with mechanical zero control.
b. Set switches on 881A as follows:

RANGE	10
NULL	0.001
polarity	+
all voltage readout dials	0 (zero)

c. Set POWER switch to LINE OPR with 881AB or to ON with 881A and allow voltmeter to warmup to equilibrium temperature (about 5 minutes).
d. Set up the necessary equipment to provide dc voltages of 100, 10, and 1 volts with an accuracy of ±(0.0015 % + 2 uv). Proceed as follows:
(1) Connect equipment as shown in figure 4-3.

CAUTION

Make sure HIGH VOLTAGE switch on 412B Power Supply is set to off.

(2) Turn on all equipment and allow it to warmup to equilibrium temperature (about 1/2 hour).
(3) Set STANDARD CELL VOLTAGE switches on 750A Reference Divider to voltage of standard cell.
(4) Set INPUT VOLTAGE switch on 750A Reference Divider to 100 volts.
(5) Set voltage dials on 412B Power Supply to 100 volts.
(6) Set HIGH VOLTAGE switch on 412B Power Supply to ON.
(7) Set 845A Null Detector to 100 MICROVOLTS.
(8) Adjust voltage dials on 412B Power Supply and COARSE and FINE dials on 750A Reference Divider for a null in each successively more sensitive null range on 845A Null Detector. The null detector should be zeroed as necessary.
(9) Voltages of 100, 10, and 1 volts dc are available at the OUTPUT VOLTAGE terminals when the OUTPUT VOLTAGE switch is set to the 100, 10 and 1 volt positions respectively.
e. Connect 881A ground post to line ground.

4-20. NULL DETECTOR CALIBRATION

a. Short INPUT post to COMMON post and null meter by adjusting electronic ZERO control (R239).
b. Set switches on 881A as follows:

RANGE	1
NULL	0.1
voltage readout dial A	1

c. Adjust 1 mv gain control R230 for full scale deflection to the left (-1).
d. Set switches on 881A as follows:

RANGE	1
NULL	0.0001
all voltage readout dials	0 (zero)

e. Null meter by adjusting electronic ZERO control (R239). Right side panel must be on instrument when making this adjustment.
f. Set voltage readout dial D to 1 and adjust 100 uv gain control R231 so that meter indicates full scale (-1) when right side panel is replaced.
g. Remove short from between INPUT and COMMON posts.

4-21. 10 VOLT RANGE CALIBRATION

a. Set switches on 881A as follows:

RANGE	10
NULL	1.0
voltage readout dials	10.00000

b. Apply 10 volts dc (±0.0015%) between INPUT and COMMON posts.
c. Adjust 10 volt range control R119 for a zero meter deflection in each successively more sensitive null range.

4-22. 1 VOLT RANGE CALIBRATION

a. Short INPUT post to COMMON post.
b. Set switches on 881A as follows:

RANGE	1
NULL	0.0001
all voltage readout dials	0 (zero)

c. Null meter by adjusting electronic ZERO control (R239). Right side panel must be on instrument when making this adjustment.
d. Remove short from between INPUT and COMMON posts.
e. Set switches on 881A as follows:

RANGE	1
NULL	0.1
voltage readout dials	1.000000

f. Apply 1 volt dc ±(0.0015% + 2 uv) between INPUT and COMMON posts.
g. Adjust 1 volt range control R121 for zero meter deflection in each successively more sensitive null range. Right side panel must be on instrument when making this adjustment.

4-23. 100 AND 1000 VOLT RANGE CALIBRATION

a. Set switches on 881A as follows:

RANGE	100
NULL	10
voltage readout dials	100.0000

b. Apply 100 volts dc (±0.0015%) between INPUT and COMMON posts.
c. Adjust input attenuator control R103 for zero meter deflection in each successively more sensitive null range. Note that this adjustment calibrates both the 100 and 1000 volt range.

4-24. CORRECTIVE MAINTENANCE

4-25. GENERAL

4-26. Since the 881A DC Differential Voltmeter is a completely transistorized instrument of conservative design, the possibility of a component failure is greatly reduced. Under normal circumstances, the only thing that will interfere with the operation of the instrument is the need for calibration. However, if the instrument does not perform correctly after calibration, the technician may use the information given here as a complete guide for locating and correcting the source of trouble. All equipment required for maintaining the instrument is listed in figure 4-1.

4-27. TROUBLESHOOTING

4-28. TROUBLESHOOTING TIPS. The purpose of troubleshooting is to quickly and accurately correct the cause of any abnormal condition. Thus, servicing should begin with an attempt to localize the general area of trouble. By performing a complete performance check as outlined in paragraph 4-8, the trouble may be isolated to the null detector, reference supply, Kelvin-Varley divider, or input attenuator. To assist in localizing some of the more common troubles that might occur, the causes and remedies for a number of symptoms are listed in the troubleshooting chart (figure 4-7). However, an understanding of the theory of operation and frequent reference to the schematic diagram is the best way to locate the cause of any abnormal condition.

SYMPTOM	PROBABLE CAUSE	REMEDY
Drift of reference supply evidenced by null detector meter needle drift when measuring an extremely stable voltage	A wire wound resistor (R108, R109, R115, R116, R118, R120, or R122) changing value with temperature. Battery voltage low. Faulty Zener diode. Q101, Q102, Q103, Q104, or Q105 defective.	Locate faulty resistor by heating slightly with a soldering iron held near resistor, while looking for a meter needle change of a standard cell measurement. Charge battery. Monitor voltage across Zener diode pair. Look for drift of Zener voltage. Replace if defective, Check by replacement.
Meter rattle or drift.	Field effect transistor Q201 defective. Chopper G201 defective. Moisture, dirt, or other contamination on printed circuit boards or switches.	Check as outlined in paragraph 4-32. If rattle is excessive, check Q201 by replacement. Check as outlined in paragraph 4-32. If rattle is excessive, check G201 by replacement. Clean instrument as outlined in paragraph 4-5.
Measurements are out of tolerance on every range when Kelvin-Varley divider is dialed to any setting other than 10999100.	Out of adjustment or one of the Kelvin-Varley divider resistors is out of tolerance.	Check accuracy of Kelvin-Varley divider using paragraph 4-35. If these checks indicate an out of tolerance condition, first try adjusting Kelvin-Varley divider using procedure of paragraph 4-41. If Kelvin-Varley divider cannot be adjusted, use out of tolerance data obtained from procedure of paragraph 4-35 to isolated defective resistor.
Meter cannot be brought to zero with ZERO control.	Chopper drive not symmetrical. CR201 or CR202 defective.	Readjust chopper drive circuit using procedure of paragraph 4-39. Check and replace if defective.
Meter beating with voltage under measurement.	Chopper drive circuit out of adjustment.	Adjust chopper drive circuit using procedure of paragraph 4-39.

Figure 4-7. TROUBLESHOOTING CHART

4-29. VISUAL INSPECTION. Trouble can sometimes be found by a thorough visual inspection. Look for:

a. Accumulations of dirt, dust, moisture, or grease. Remove contamination as outlined in periodic maintenance (paragraph 4-5).

b. Scorched or burned parts. Damage of this type is often due to some other defective component. Determine cause of damage before replacing overheated part.

CAUTION

Avoid touching polyethelene grommets. The grease on the hands of some people can cause excessive electrical leakage.

c. Cracks, cuts, and other damage to polyethelene grommets. Replace grommets using a plastic bag over the hand to prevent contamination.

d. Input divider resistors (R100, R101, and R102) touching printed circuit board. When these resistors touch the board, leakage paths are created which can result in meter offset.

e. Loose or intermittent connections.

f. Any other condition which suggests a source of trouble.

4-30. VOLTAGE LEVEL CHECKING. When the trouble has been localized to a stage, the defective part may be isolated by voltage level measurements at the transistor terminals. Figure 4-8 may be used to locate the transistor terminals. When making measurements on printed circuit boards, use a sharp probe and press firmly while rotating probe to break through the insulating coating. Measurements that differ widely from those listed in the transistor voltage chart (figure 4-9) can be used along with the schematic to localize the trouble to a specific part, in most cases.

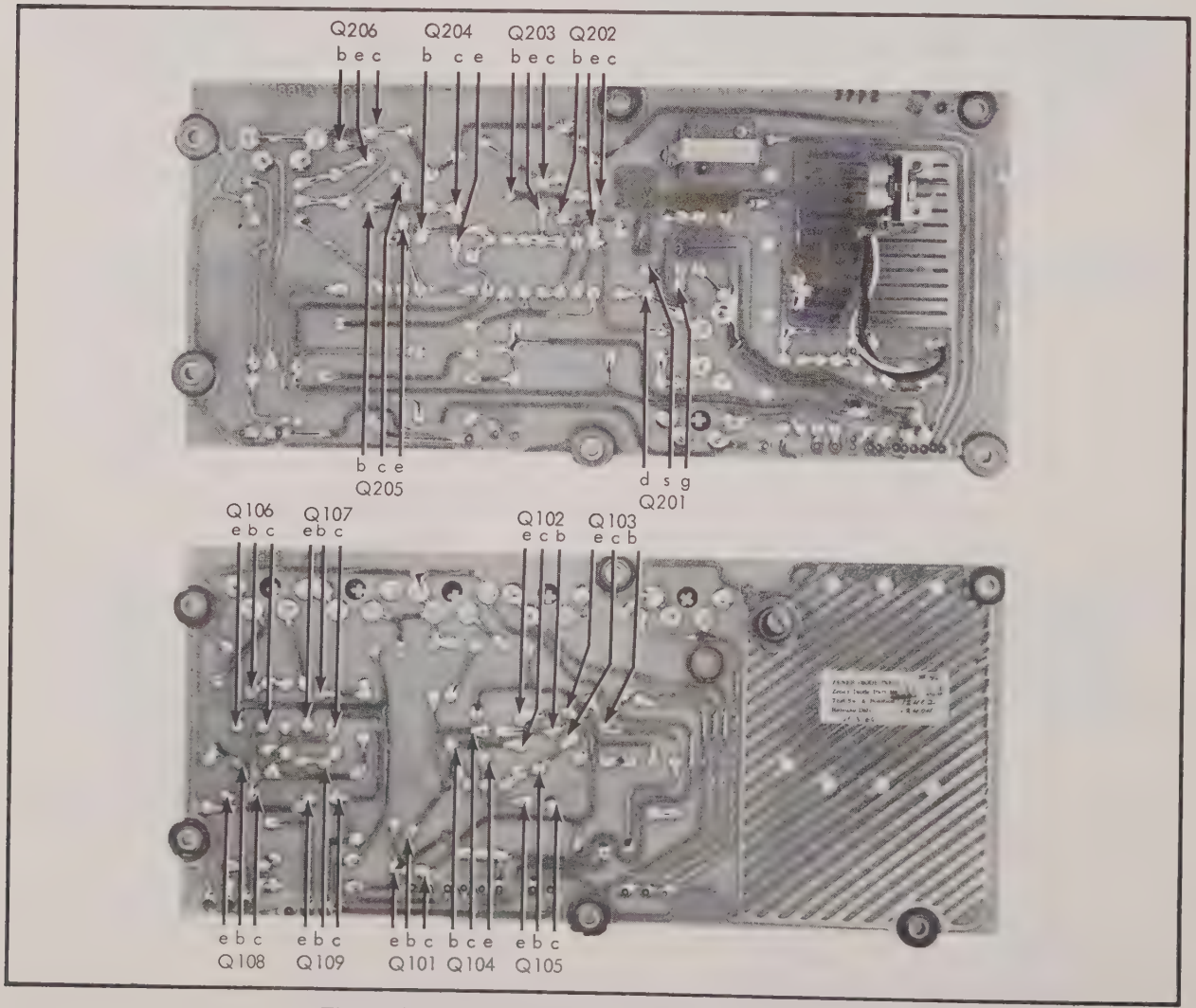


Figure 4-8. TRANSISTOR TERMINAL LOCATIONS

TRANSISTOR	EMITTER	BASE	COLLECTOR
Q101	-30. (1)	-29.4	-18.0 (2)
Q102	-13.	-12.4	- 7.1
Q103	-13.	-12.4	- 6.7
Q104	- 6.5	- 7.1	-29.4
Q105	- 6.5	- 6.7	-18.0 (2)
Q106	6.9 (3)	5.9	3.0
Q107	6.9 (3)	5.9	3.0
Q108	0	.16	3.0
Q109	0	.16	3.0
Q201	-3.3 (SOURCE)	0 (GATE)	-10 (DRAIN)
Q202	-16.6	-16	-12.4
Q203	-13.	-12.4	-10
Q204	-18.0 (2)	-17.4	-15.4
Q205	-16.	-15.4	- 9.5
Q206	0	+ 2.5	0

The above operating voltage levels are measured under the following conditions: (a) line voltage at 115/230 vac, 50 to 440 cps; (b) all voltages measured with a 3%, 10 megohm, 5 pf voltmeter from specified terminal to the reference-supply/null-detector common. The COMMON post is reference supply - null detector common when in TVM mode or when in a NULL mode with all voltage dials set to 0 and polarity switch set to +; (c) some voltages may vary as much as 15 to 20%; (d) bias voltages (difference between emitter and base voltages) should remain approximately the same; (e) all voltages are dc unless otherwise indicated.

NOTES: (1) Emitter of Q101 as measured with a differential voltmeter should be between -26 and -34 vdc for 115/230 vac line operation, -19.5 and -21.0 vdc for BAT OPR (881AB only), and not less than -23.5 vdc for BAT CHG (881AB only). (2) Collector of Q101 and Q105 and emitter of Q204 should be between -17.9 and -18.1 vdc as measured with a differential voltmeter. (3) Emitter of Q106 and Q107 as measured with a differential voltmeter should be between +6.3 and +7.0 vdc for ON (881A) and LINE OPR (881AB) at 115/230 vac line and +4.9 and +5.3 vdc for BAT OPR (881AB only).

Figure 4-9. TRANSISTOR VOLTAGE CHART

CAUTION

When measuring voltage, it is recommended that care be used to avoid momentary short circuits which could damage components.

4-31. TROUBLESHOOTING CHECKS. The following troubleshooting checks list several normal conditions that should exist in the instrument. The most probable cause or causes of an abnormal condition in these checks is also given.

4-32. Meter Rattle Check. If the meter needle appears to rattle excessively, perform the following check:

a. Set switches on 881A as follows:

RANGE	1
NULL	.0001
ac-dc polarity	+
all voltage readout dials	0 (zero)

b. Set POWER switch to LINE OPR with 881AB or to ON with 881A and allow a 5 minute warmup period.

c. Short INPUT post to COMMON post. Random excursions of meter needle should be less than 1 small division peak-to-peak. If rattle is excessive, check field-effect transistor Q201 by replacement. If meter rattle is still excessive, chopper is probably faulty.

4-33. Reference Voltage Regulation Check. If the reference voltage is suspected of being faulty, perform the following check:

a. Connect adjustable autotransformer to line power.

b. Connect 881A line cord to output of autotransformer.

c. Set POWER switch to LINE OPR with 881AB or to ON with 881A and allow a 5 minute warmup period.

d. Set autotransformer to 103 volts (207 volts when 881A is wired for 230 volts nominal) as measured with a VTVM.

e. Set NULL switch to TVM and polarity switch to 4.

f. Differentially measure -18 volt supply between COMMON post and collector of Q101 with a differential voltmeter.

g. Set autotransformer to 127 volts (253 volts when 881A is wired for 230 volts nominal) as measured with a VTVM. Output of -18 volt supply should change by less than 3.5 millivolts from step f. If regulation is excessive, check transistors Q101 through Q105.

4-34. Common Mode Measurement Check. If the instrument is suspected of making incorrect common mode measurements, perform the following check:

a. Measure the voltage of a standard cell in the 1 volt range and in the positive polarity.

b. Connect 500 volts dc from chassis ground post to COMMON post and wait about 3 minutes.

c. Measure voltage of standard cell. If the measurements are not within 50 microvolts of each other, there is excessive electrical leakage to ground. Clean instrument as instructed in paragraph 4-5.

4-35. Kelvin-Varley Divider Check. The Kelvin-Varley check requires that connections to the Kelvin-Varley divider be made inside the instrument. Also, the Kelvin-Varley check takes a considerable amount of time to perform. Therefore, this check should be performed only if the differential measurement check (paragraph 4-13) indicates there is a problem or if the Kelvin-Varley divider has been adjusted (paragraph 4-41). Proceed as follows:

a. Disconnect 881A from line power.

b. Set POWER switch to OFF and set NULL switch to TVM.

c. Remove bottom panel and top-back panel.

d. Locate high input (wire from Kelvin-Varley board to range switch S2, usually purple or point 13 on Kelvin-Varley board), high output (wire from R12 to null switch S3, usually yellow), and input-output common (wire from Kelvin-Varley board to voltage dial A, S5, usually black or point 1 on Kelvin-Varley board) of Kelvin-Varley divider.

CAUTION

Make sure HIGH VOLTAGE switch on 412B Power Supply is set to off.

e. Connect equipment as shown in figure 4-10.

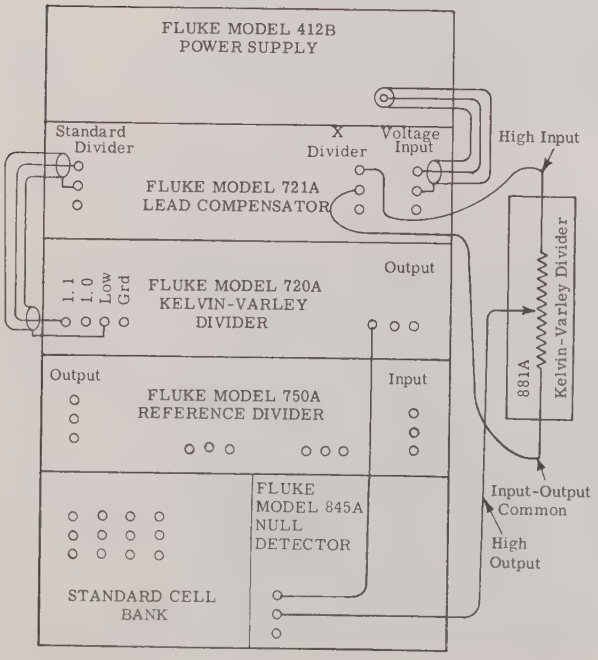


Figure 4-10. KELVIN-VARLEY DIVIDER CHECK SETUP

f. Turn all equipment on and allow it to warmup to equilibrium temperature (about 1/2 hour).

g. Set voltage dials on 412B Power Supply for an output of 11.0 volts dc.

h. Set 881A voltage readout dials to 000000 and 720A Kelvin-Varley Divider dials to 0000000.

i. Set 845A Null Detector to 30 MICROVOLTS.

j. Set function switch to VOLTAGE OFF on 721A Lead Compensator.

k. Zero 845A Null Detector.

l. Set function switch to $R_S > R_X$ on 721A Lead Compensator.

m. Adjust LOW BALANCE controls on 721A for a null on 845A. It may be necessary to temporarily reduce sensitivity of 845A to find null point on LOW BALANCE controls.

n. Set 881A voltage dials to 10999100 and 720A Kelvin-Varley dials to 109999910.

o. Set function switch to VOLTAGE OFF on 721A Lead Compensator.

p. Zero 845A Null Detector.

q. Set function switch to $R_S > R_X$ on 721A Lead Compensator.

r. Adjust HIGH BALANCE controls on 721A for a null on 845A. It may be necessary to temporarily reduce sensitivity of 845A to find null point on HIGH BALANCE controls.

s. Set 845A Null Detector to 300 MICROVOLTS and change to 100 MICROVOLTS and 30 MICROVOLTS as required.

t. Set 881A voltage readout dials and 720A Kelvin-Varley Divider dials to first positions shown in figure 4-11.

u. Set function switch to VOLTAGE OFF on 721A Lead Compensator.

v. Zero 845A Null Detector.

w. Set function switch to $R_S > R_X$ on 721A Lead Compensator. The 845A Null Detector indication should be equal to or less than the listed deviation.

x. Repeat steps u through w for remaining switch positions shown in figure 4-11. If Kelvin-Varley divider is out of tolerance between settings of 1000000 and 0999100, readjust as set forth in paragraph 4-41. If a resistor-trimmer combination of the first deck can not be adjusted for a null during adjustment, the 4999.2 ohm resistor is defective and must be replaced. If Kelvin-Varley divider is out of tolerance for remaining settings, make sure padding trimmers are adjusted correctly (paragraph 4-41) before attempting to replace a resistor.

4-36. ELECTRONIC ADJUSTMENTS.

4-37. The following electronic adjustments are not performed during calibration because they may never require adjusting during the life of the instrument under normal circumstances. All controls may be located with the aid of figure 4-6.

4-38. NEGATIVE 18 VOLT SUPPLY ADJUSTMENT. Sampling string resistor R110 should be adjusted whenever a part in the -18 volt power supply is replaced. If R110 is adjusted, it will be necessary to perform the 10 volt and 1 volt range calibration (paragraph 4-21 and 4-22). Proceed as follows:

a. Set POWER switch to LINE OPR with 881AB or to ON with 881A.

881A Voltage Dial Settings	Standard Divider Settings	Maximum Deviation * (± microvolts)
1000000	10000000	200
9999100	10000000	200
900000	9000000	180
8999100	9000000	180
800000	8000000	160
7999100	8000000	160
700000	7000000	140
6999100	7000000	140
600000	6000000	120
5999100	6000000	120
500000	5000000	100
4999100	5000000	100
400000	4000000	80
3999100	4000000	80
300000	3000000	60
2999100	3000000	60
200000	2000000	40
1999100	2000000	40
100000	1000000	20
0999100	1000000	20
090000	0900000	20
0899100	0900000	20
080000	0800000	20
0799100	0800000	20
070000	0700000	20
0699100	0700000	20
060000	0600000	20
0599100	0600000	20
050000	0500000	20
0499100	0500000	20
040000	0400000	20
0399100	0400000	20
030000	0300000	20
0299100	0300000	20
020000	0200000	20
0199100	0200000	20
010000	0100000	20
0099100	0100000	20
009000	0090000	20
0089100	0090000	20
008000	0080000	20
0079100	0080000	20

881A Voltage Dial Settings	Standard Divider Settings	Maximum Deviation * (± microvolts)
007000	0070000	20
0069100	0070000	20
006000	0060000	20
0059100	0060000	20
005000	0050000	20
0049100	0050000	20
004000	0040000	20
0039100	0040000	20
003000	0030000	20
0029100	0030000	20
002000	0020000	20
0019100	0020000	20
001000	0010000	20
0009100	0010000	20
000900	0009000	20
0008100	0009000	20
000800	0008000	20
0007100	0008000	20
000700	0007000	20
0006100	0007000	20
000600	0006000	20
0005100	0006000	20
000500	0005000	20
0004100	0005000	20
000400	0004000	20
0003100	0004000	20
000300	0003000	20
0002100	0003000	20
000200	0002000	20
0001100	0002000	20
000100	0001000	20
0000100	0001000	20
000090	0000900	20
000080	0000800	20
000070	0000700	20
000060	0000600	20
000050	0000500	20
000040	0000400	20
000030	0000300	20
000020	0000200	20
000010	0000100	20
000000	0000000	0

* Input voltage: 11.0 vdc

Figure 4-11. KELVIN-VARLEY DIVIDER ERROR LIMITS

b. Set NULL switch to TVM.
c. Connect a differential voltmeter between COMMON post and junction of C104 and R112.
d. Set up differential voltmeter to differentially measure -18.0 volts dc.
e. Adjust R110 for -18.0 (±0.1) volts.
f. Perform 10 volt and 1 volt range calibration.

4-39. CHOPPER DRIVE CIRCUIT ADJUSTMENT. The chopper drive circuit should be adjusted for symmetry and frequency if a part in the chopper drive circuit is replaced, if there is difficulty in zeroing the meter, or if line operation causes the meter to beat due to the relationship of the chopper frequency with the line power frequency. Proceed as follows:

a. Set POWER switch to LINE OPR with 881AB or to ON with 881A.
b. Set NULL switch to TVM and polarity switch to +.
c. Connect oscilloscope between COMMON post and one side of the chopper drive coil G201 to observe the output waveform.
d. Adjust R125 until output is within ±10% of symmetry.
e. Adjust R123 for a frequency of 84 (±1) cps.

4-40. NULL DETECTOR INPUT STAGE BIAS ADJUSTMENT. The bias of field-effect transistor Q201 should be adjusted if it or any component in its drain-sink circuit is replaced. Proceed as follows:

a. Set POWER switch to LINE OPR with 881AB or to ON with 881A.
b. Set NULL switch to TVM and polarity switch to +.
c. Adjust R208 until voltage from COMMON post to drain of Q201 (junction of C207 and R207) is -10 (±0.5) volts as measured with a VTVM.

4-41. KELVIN-VARLEY DIVIDER ADJUSTMENT. The Kelvin-Varley divider should be adjusted only after a resistor has been replaced or after the Kelvin-Varley divider check (paragraph 4-35) indicates that the Kelvin-Varley divider is out of tolerance. Proceed as follows:

a. Disconnect 881A from power line.
b. Set POWER switch to OFF and NULL switch to TVM.
c. Remove bottom cover.
d. Open jumpers marked with a U, V, W, X, Y, and Z by unsoldering one end and pulling it loose. Also unsolder high input of Kelvin-Varley divider (wire from Kelvin-Varley board to range switch S2, usually purple).
e. Connect equipment as shown in figure 4-12.

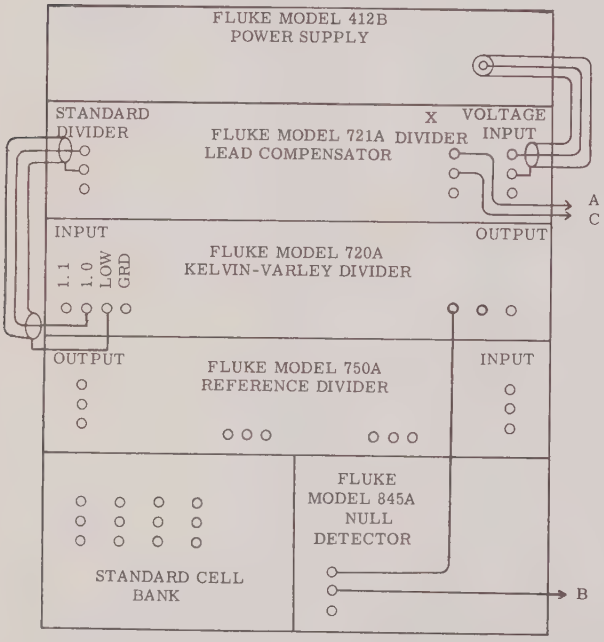


Figure 4-12. KELVIN-VARLEY DIVIDER ADJUSTMENT SETUP

f. Turn on all equipment and allow it to warmup to equilibrium temperature (about 1/2 hour).

CAUTION

Do not allow power supply voltage to exceed 10 volts as damage to the Kelvin-Varley resistors may result.

g. Set 412B Power Supply for an output of 4 volts dc.
h. Connect points A and C of figure 4-12 to test points 14 and 16 of Kelvin-Varley board respectively.
i. Eliminate errors due to resistance of leads and connections as follows:
(1) Set 845A Null Detector to 30 MICROVOLTS.
(2) Set 720A Kelvin-Varley Divider dials to 0000000.
(3) Connect point B of figure 4-12 to test point that point C is connected to.
(4) Set function switch to VOLTAGE OFF on 721A Lead Compensator.
(5) Adjust ZERO control to null meter on 845A Null Detector.
(6) Set function switch to $R_S > R_X$ on 721A Lead Compensator.
(7) Adjust LOW BALANCE controls on 721A Lead Compensator for a null on 845A. It may be necessary to temporarily reduce sensitivity of 845A to find null point on LOW BALANCE controls.
(8) Set 721A Kelvin-Varley Divider dials to 10000000.
(9) Connect point B of figure 4-12 to test point that point A is connected to.
(10) Repeat steps (4), (5), and (6).
(11) Adjust HIGH BALANCE controls on 721A for a null on 845A. It may be necessary to temporarily reduce sensitivity of 845A to find null point on HIGH BALANCE controls.
j. Set voltage dial E to 50.
k. Connect point B of figure 4-12 to test point 15.
l. Set 720A Kelvin-Varley Divider to 5000000.
m. Eliminate error due to thermal voltages as follows:
(1) Set function switch to VOLTAGE OFF on 721A Lead Compensator.
(2) Set 845A Null Detector to 30 MICROVOLTS and adjust ZERO control to null meter.
(3) Set function switch to $R_S > R_X$ on 721A Lead Compensator.
n. Set 845A Null Detector to 1 MILLIVOLT.
o. Adjust R303 (at point P) to within ±200 microvolts of null.
p. Reconnect points A and C to test points 17 and 18 respectively.
q. Solder down jumpers Z and Y.
r. Repeat step i.
s. Connect point B to test point 19.
t. Repeat steps m and n.
u. Adjust R316 (at point N) to within ±50 microvolts of null.
v. Reconnect points A and C to test points 20 and 21 respectively.
w. Solder down jumpers X and W.
x. Repeat step i.
y. Connect point B to test point 22.
z. Repeat steps m and n.
aa. Adjust R329 (at point M) to within ±20 microvolts of null with 845A Null Detector set to 100 MICROVOLTS.
ab. Set 412B Power Supply for an output of 18 volts dc.
ac. Reconnect points A and C to test points 23 and 24 respectively.
ad. Solder down jumper V.
ae. Repeat step i.
af. Connect point B to test point 25.
ag. Set 720A Kelvin-Varley Divider dials to 6666667.
ah. Make adjustments as given in each horizontal line of figure 4-13.
ai. Solder down jumper U and high input wire of Kelvin-Varley divider.
aj. Check accuracy of Kelvin-Varley divider using procedure of paragraph 4-35.

4-42. MECHANICAL DRUM ADJUSTMENTS

4-43. Occasionally the need may arise to align the po-

Set Voltage Dial A To	Short Test Points	Eliminate Thermal Voltage Errors as in step m	Set 845A Null Detector to 100 microvolts	Adjust Control to Within ±15 microvolts of Null at Point		Remove Short from Between
0	2 to 3	"	"	R364	A	2 and 3
0	1 to 2	"	"	R362	B	1 and 2
2	4 to 5	"	"	R360	C	4 and 5
2	3 to 4	"	"	R358	D	3 and 4
4	6 to 7	"	"	R356	E	6 and 7
4	5 to 6	"	"	R354	F	5 and 6
6	8 to 9	"	"	R352	G	8 and 9
6	7 to 8	"	"	R350	H	7 and 8
8	10 to 11	"	"	R348	I	10 and 11
8	9 to 10	"	"	R346	J	9 and 10
10	12 to 13	"	"	R344	K	12 and 13
10	11 to 12	"	"	R342	L	11 and 12

Figure 4-13. KELVIN-VARLEY "A" DECK ADJUSTMENT

larity switch drum or one of the voltage dial drums in the readout windows. Also, if the drive gear on a switch or dial shaft is no longer in line with the drum shaft, the gears may bind as the dials are turned. Proceed as follows:

a. Remove both side front-covers and the bottom cover from 881A.
b. Stand instrument on rear.
c. Make sure that drive gear on polarity switch shaft and drive gear on shaft of voltage dial E are in line with drum shaft. If not, loosen set screw of drive gear with a 1/16" hex key and align drive gear with drum shaft.
d. Loosen adjusting bracket at left side of instrument and position drum shaft up or down until there is just discernible backlash. That is, until polarity drum just moves when rotated with a finger without moving drive gear on polarity switch shaft.
e. Loosen adjusting bracket at right side of instrument and position drum shaft until there is just discernible backlash for drum of voltage dial E.
f. Turn polarity switch and all voltage dials fully counterclock wise.
g. Loosen set screw of drive gear for drum being aligned and slide drive gear toward back of instrument.

NOTE

See step 1. for adjustment of voltage dial E.

h. Insert finger through window and hold drum being aligned in desired position.
i. Insert hex key into set screw of drive gear and lift drive gear into place allowing it to turn counter clockwise as the teeth mesh.
j. When drive gear is in line with drum shaft tighten set screw.
k. Check character alignment in window. If necessary, loosen set screw and rotate drive gear slightly for final adjustment.
l. To align drum for voltage dial E, loosen set screw of drive gear and slide toward rear of instrument.
m. Insert hex key into set screw of drive gear and lift drive gear into alignment with drive shaft while noting how much drum turns.
n. Slide drive gear toward rear of instrument.
o. Position drum so that oo position will line up with pointer when gear is raised into position.
p. Raise drive gear into alignment with drum shaft and position 00 in line with pointer by rotating drive gear slightly before tightening set screw.

SECTION V

LIST OF REPLACEABLE PARTS

5-1. INTRODUCTION

5-2. This section contains information necessary to describe all normally replaceable parts. Separate assembly lists are used to describe the parts on the final assembly and various assemblies and subassemblies. Each list has a corresponding illustration on which the parts for that list are identified. Parts are called out on both lists and illustrations by reference designations from the schematic diagram. Those parts (mechanical) which have no reference designation are shown on the illustrations by Fluke stock number.

5-3. Each list provides the following information on each part:

a. The REFERENCE DESIGNATION column indicates the reference designation used on the schematic diagram.

b. The DESCRIPTION column describes the part in words, along with any applicable values, tolerances, etc. Indentation is used to show assembly, subassembly, and parts relationship. See abbreviations and symbols on next page.

c. Entries in the FLUKE STOCK NUMBER column indicate the number by which Fluke stocks the part. This number should be used when ordering parts from the Fluke factory or your Fluke representative.

d. Entries in the MFR. column indicate a typical manufacture of the part by the manufacturer's code number. Appendix A lists the manufacturers and their code numbers.

e. Entries in the MFR. PART NO. column are part numbers assigned by the manufacturer indicated in the Mfg. column.

f. The number in the TOTAL QTY column indicates the total quantity of the part used in the instrument. "REF" indicates that the total quantity of the part has been previously given. The total quantity of each part is listed the first time the part appears. All other listings of the same part refer back to the reference designation of the first appearance of the part for the total quantity.

g. The number in the REC. QTY. column indicates the recommended spares quantity necessary to support approximately one to five instruments for a period of two years. The basis used to select the recommended spares quantity is that a small group of parts will be required to correct a majority of the problems that occur. Since there is a chance that any part may fail, a stock of at least one of every part used in addition to the recommended parts will be needed for complete maintenance during one year of isolated service.

h. The USE CODE column identifies certain parts which have been added, deleted, or modified during production of the instrument. Each part for which a use code has been assigned may be identified with a particular instrument serial number by consulting the Use Code Effectivity List at the end of this section. These changes are normally made when improved components become available or when the latest circuit improvements are developed by our engineering department. The serial number listed indicates the instruments in which that particular part was used. The symbol "~" is used to indicate an approximate serial number. If a different part should be used for replacement, it is listed by Fluke stock number in the description column.

5-4. HOW TO OBTAIN PARTS

5-5. Standard components have been used whenever possible. Thus, most parts can be obtained locally. However, parts may be ordered directly from the manufacturer using the manufacturer's part number or from Fluke using the Fluke stock number. In addition, the most commonly replaced parts that can not be obtained locally may be obtained from your Fluke representative. If a part you have ordered has been replaced by a new or improved part, Fluke will normally send you this part along with an explanation.

5-6. When ordering parts from Fluke always include:

a. Reference designation, description, and Fluke stock number.

b. Instrument model and serial number.

c. Most structural parts are not listed. In this case, give complete description, function, and location of part.

5-7. ABBREVIATIONS

ac	alternating current
Al	aluminum
assy	assembly
cap	capacitor
car flm	carbon film
cer	ceramic
comp	composition
conn	connector
cps	cycles per second
db	decibel
dc	direct current
dpdt	double pole double throw
dpst	double pole single throw
elect	electrolytic
fxd	fixed
Ge	germanium
gmv	guaranteed minimum value
Hz	hertz (cycles per second)
K	kilohm
kc or Kc	kilocycle
kHz or KHz	kilohertz (kilocycles per/sec)
kv	kilovolt
kva	kilovolt-ampere
ma	milliampere
Mc or MC	megacycle
MHz	megahertz (megacycles per/sec)
meg or M	megohm
met flm	metal film
mfg	manufacturer
mv	millivolt
mw	milliwatt
na	nanoampere
pf	picofarad
piv	peak inverse voltage
plstc	plastic
pp	peak-to-peak
ppm	parts per million
rect	rectifier
res	resistor
rms	root-mean-square
sb	slow-blow
Si	silicon
S/N	serial number
sw	switch
spdt	single pole double throw
spst	single pole single throw
Ta	tantalum
tc	temperature coefficient
tstr	transistor
ua	microampere
uf	microfarad
uv	microvolt
va	volt ampere
vac	alternating current volts
var	variable
vdc	direct current volts
w	watt
wvdc	direct current working volts
ww	wirewound

5-8. PREFIX SYMBOLS

T	tera	10^{12}
G	giga	10^{9}
M	mega	10^{6}
K or k	kilo	10^{3}
h	hecto	10^{2}
da	deka	10
d	deci	10^{-1}
c	centi	10^{-2}
m	milli	10^{-3}
u	micro	10^{-6}
n	nano	10^{-9}
p	pico	10^{-12}
f	femto	10^{-15}
a	anto	10^{-18}

5-9. QUANTITY SYMBOLS

a or amp	ampere
f	farad
h	henry
hr	hour
Ω	ohm
sec	second
v or V	volt
w or W	watt

5-10. SPECIAL NOTES AND SYMBOLS

~ 000	Approximate serial number
Use 0000-000000	Part number indicated should be used if replacement is required.

REF DESIG.	DESCRIPTION	FLUKE STOCK NO.	MFR.	MFR. PART NO.	TOT. QTY.	REC. QTY.	USE CODE
	Final Assembly (line powered model)	881A			-		
	(battery-line powered model)	881AB					
	Front Panel Assembly (see Figure 5-2)						
	881A only	3158-163246 (881A-408)	89536	3158-163246	1		
	881AB only	3158-163295 (881AB-404)	89536	3158-163295	1		
	Reference Supply Board Assembly (see figure 5-3)	1702-163220 (881A-403)	89536	1702-163220	1		
	Null Detector Board Assembly (see figure 5-4)	1702-163212 (881A-402)	89536	1702-163212	1		
	Kelvin-Varley Chassis Assembly (see figure 5-5)	3158-162495 (881A-404)	89536	3158-162495	1		
BT1	Battery, nickel-cadmium, 1.2V (881AB)	4002-160390	06860	1.2 SC	4		
BT2	Battery, nickel-cadmium, 9.6V (881AB)	4002-160408	06860	9.6V/500BH	2		
CR1, CR2	Diode, Si, 1 amp, 100 PIV (881AB)	4802-116111	05277	IN4817	4	1	
F1	Fuse, 1/16 amp, slow blowing (for 115 volt operation)	5101-163030	03614	Type MDL	1	2	P
	Fuse, 1/8 amp, slow blowing (for 115 volt operation)	5101-166488	03614	Type MDL	1	2	Q
	Fuse, 1/32 amp, slow blowing (for 230 volt operation)	5101-163022	03614	Type MDL	1	2	P
	Fuse, 1/16 amp, slow blowing (for 230 volt operation)	5101-163030	03614	Type MDL	1	2	Q
	Fuse holder	2101-160846	75915	342004	1		
J4, J5	Binding post, red	2811-142976	58474	DF31RC	2		
P1, J6	Line Cord Assembly	6005-161638	89536	6005-161638	1		
P2	Plug, 3 prong	2109-160275	01730	M-1550-GS	1		
R2, R3	Res, met flm, 4.5M ±1%, 1W	4705-159418	14298	CM-1	2		
R4	Res, met flm, 900K ±1%, 1W	4705-159509	72982	Type MF8C-TO	1		
R5	Res, met flm, 90K ±1%, 1/2W	4705-159426	72982	Type MF7C-TO	1		
R6	Res, met flm, 9K ±1%, 1/2W	4705-159434	72982	Type MF7C-TO	1		
R7	Res, met flm, 1K ±1%, 1/2W	4705-151324	72982	Type MF7C-TO	2		
R8	Res, comp, 12Ω ±5%, 1W (881AB)	4704-163071	01121	GB1205	1		
R9	Res, comp, 130Ω ±5%, 1W (881AB)	4704-163055	01121	GB1315	1		
R10	Res, var comp, 10K ±20%, 1/2W	4701-162800	12697	Series 37	1		
R11	Res, comp, 62K ±5%, 1/2W (881AB)	4704-108522	01121	EB6235	1		

REF DESIG.	DESCRIPTION	FLUKE STOCK NO.	MFR.	MFR. PART NO.	TOT. QTY.	REC. QTY.	USE CODE
S1	SW, power (881A)	5105-162693 (881A-821)	89536	5105-162693	1		
	SW, power (881AB)	5105-163360 (881AB-801)	89536	5105-163360	1		
S2	SW, range	5105-162677 (881A-814)	89536	5105-162677	1		
S3	SW, null	5105-162669 (881A-813)	89536	5105-162669	1		
S4	SW, polarity	5105-162685 (881A-815)	89536	5105-162685	1		
T1	Transformer	5602-162818 (881A-651)	89536	5602-162818	1		
	Cover, large side	3156-162172 (881A-202)	89536	3156-162172	2		
	Cover, small side	3156-162164 (881A-201)	89536	3156-162164	2		
	Cover, top-back	3156-162180 (881A-203)	89536	3156-162180	1		
	Cover, bottom	3156-162198 (881A-204)	89536	3156-162198	1		
	Handle	2404-101857	12136	919-415-173	1		
	Knob, power	3156-162347 (881A-219)	89536	3156-162347	1		
	Knob, polarity and voltage dials	2405-158949 (881A-819)	89536	2405-158949	6		
	Knob, null and range	2405-158956 (881A-820)	89536	2405-158956	2		
	Rubber foot	2819-101253 2819-103309	98388 83478	BH-2097 9102-W	- 4		A B
	Tilt stand	3153-163386 (881A-826)	89536	3153-163386	1		

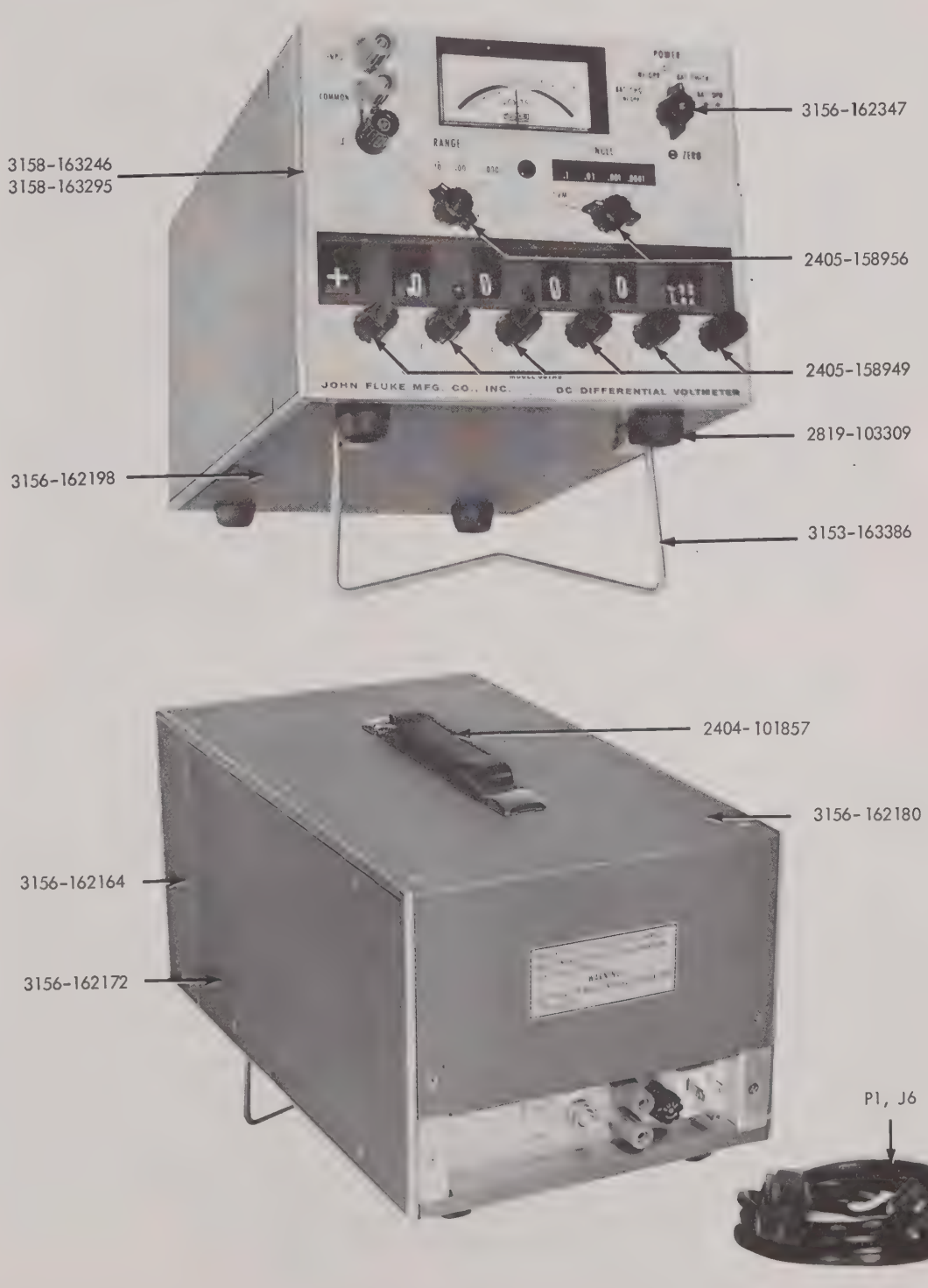


Figure 5-1. FINAL ASSEMBLY (sheet 1 of 2)

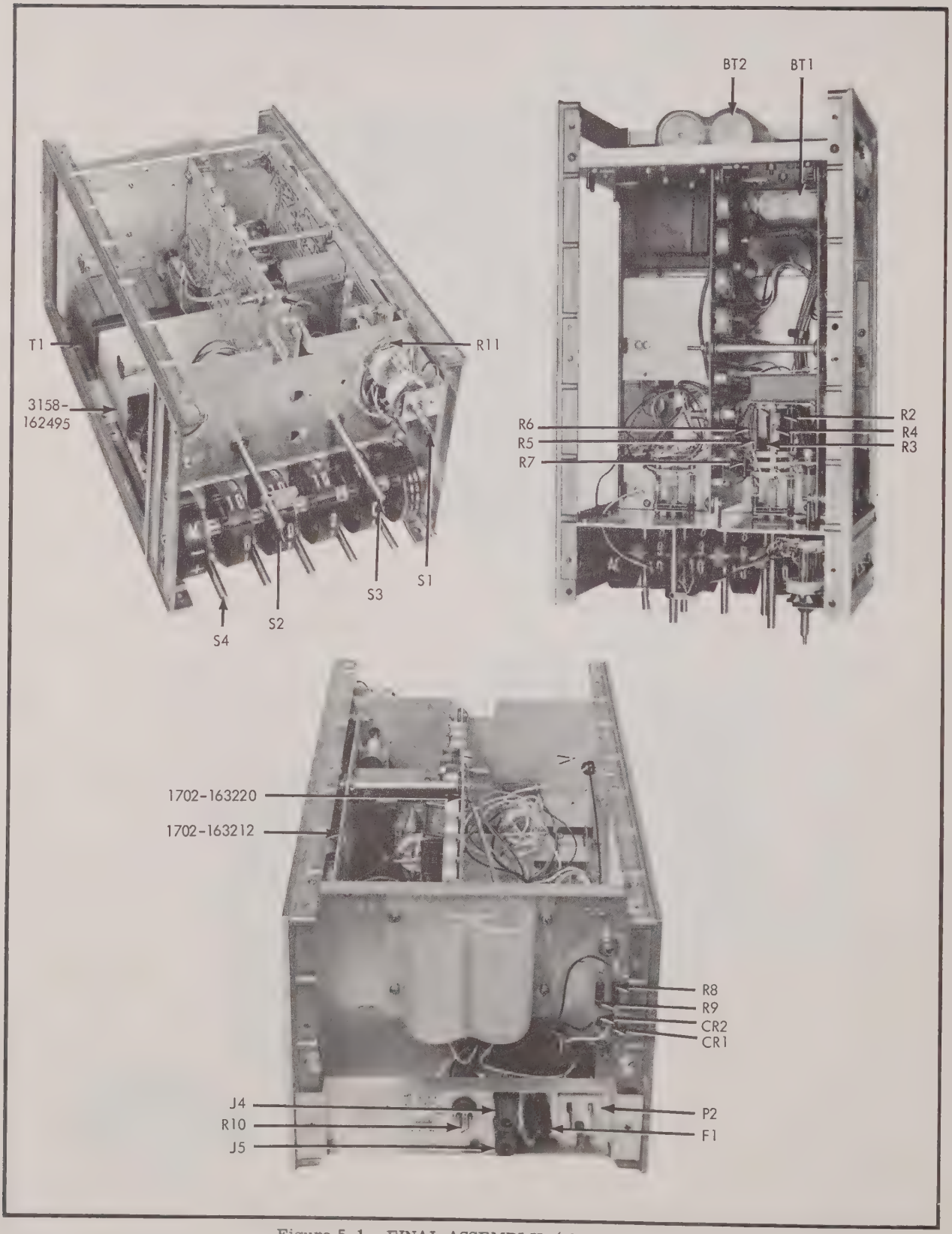


Figure 5-1. FINAL ASSEMBLY (sheet 2 of 2)

REF DESIG.	DESCRIPTION	FLUKE STOCK NO.	MFR.	MFR. PART NO.	TOT. QTY.	REC. QTY.	USE CODE
	Front Panel Assembly 881A only	3158-163246 (881A-408)	89536	3158-163246	REF		
	881AB only	3158-163295 (881A-404)	89536	3158-163295	REF		
C1	Cap, plstc, 0.01 uf ±20%, 1000V	1507-159996	84411	663UW103010W	1		
C2*	Cap, elect, 640 uf, -10% + 50%, 6.4V	1502-178608	73445	C437ARC640	1		
J1, J2	Binding post, red	2811-149856	58474	BHB-10208-G22	2		
J3	Binding post, black	2811-149864	58474	BHB-1028-G21	1		
M1*	Meter, 100-0-100 ua, 900Ω (881A)	2901-201236	89536	2901-201236	1		
	Meter, 100-0-100 ua, 900Ω (881AB)	2901-201244	89536	2901-201244	1		
R1	Res, comp, 47K ±5%, 1/2W	4704-108738	01121	EB4735	0		C
R13*	Res, comp, 270Ω ±10%, 1/2W	4704-108241	01121	EB2711	1		
	Shorting link	2811-101220	24655	938L	1		
	Null Range Shutter	3156-162236 (881A-211)	89536	3156-162263	1		
	Nylon Bushing	2502-160499	96881	4L2-FF	9		

*C2 and R13 provide meter damping. On some instruments, a different meter is used not requiring external damping. The above listing is the preferred replacement.

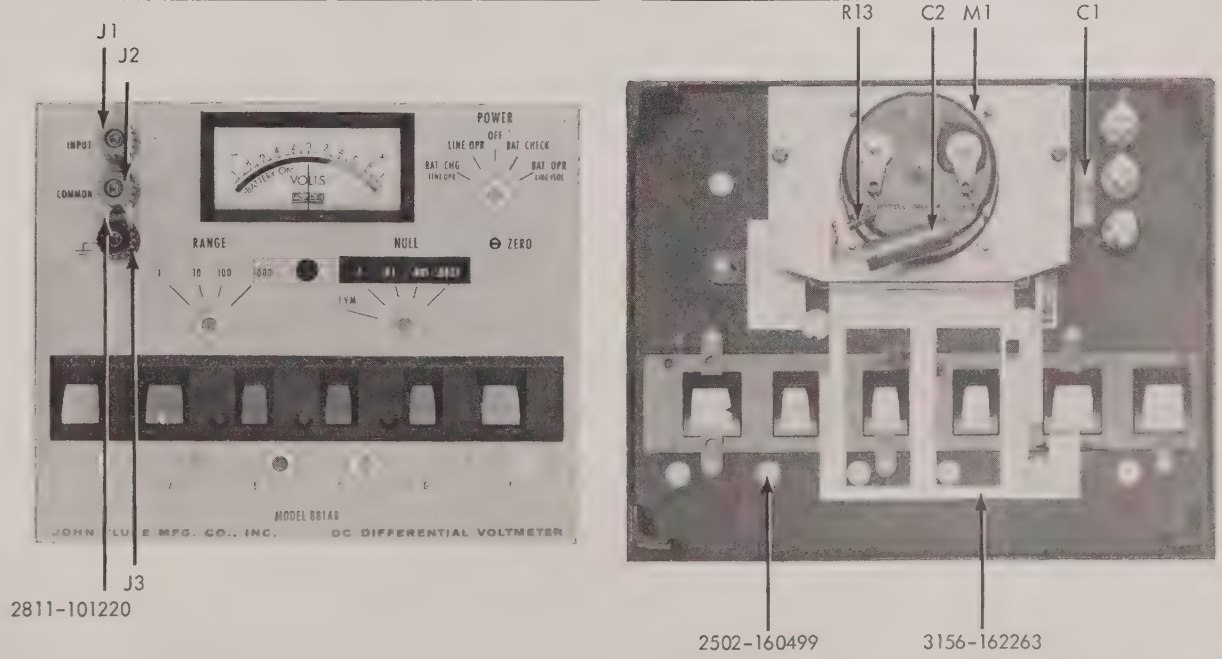


Figure 5-2. FRONT PANEL ASSEMBLY

REF DESIG.	DESCRIPTION	FLUKE STOCK NO.	MFR.	MFR. PART NO.	TOT. QTY.	REC. QTY.	USE CODE
	Reference Supply Board Assembly without transistors	1702-163220 (881A-403)	89536	1702-163220	REF		
C101	Cap, Al elect, 500 uf -10/+150%, 15V	1502-160101	88419	BR500-15	1	1	
C102	Cap, Al elect, 150 uf -10/+150%, 50V	1502-160119	88419	BR150-50	1	1	
C103	Cap, plstc, 0.022 uf ±10%, 75V	1507-159400	56289	192P2239R75	1		
C104	Cap, plstc, 0.22 uf ±10%, 75V	1507-159392	56289	192P2249R75	2		
C105, C106	Cap, Ta elect, 2.2 uf ±10%, 20V	1508-160226	05397	K2R2C20K	3	1	
C107	Cap, plstc, 0.22 uf ±10%, 75V	1507-159392	56289	192P2249R75	REF		
CR101, CR102	Diode, Si, 1 amp, 100 PIV 881A	4802-116111	05277	IN4817	2		
	881AB	4802-116111	05277	IN4817	REF		
Q101	Tstr, Si, NPN (use 117135)	4805-153551	07910	CDQ10449	-		~D
	Tstr, Si, NPN (for Q101 replacement use 4805-203489)	4805-117135	95303	2N2270	1	1	~E
Q102 to Q103	Tstr, Si, NPN (for replacement use 4805-203489)	4805-153551	07910	CDQ10449	6	2	
Q104	Tstr, Si, PNP (Use 4805-190389)	4805-159491	73293	605-9			~H
	Tstr, Si, PNP	4805-190389	04713	SM-4144	1	1	~I
Q105	Tstr, Ge, PNP	4805-163188	01295	2N404			
Q106, Q107	Tstr, Ge, NPN	4805-148643	01295	2N1307	2	1	
Q108, Q109	Tstr, Ge, NPN	4805-117127	01295	2N1304	2	1	
R103	Res, var WW, 10K ±10%, 2W	4702-163147	71450	Type 118	1		
R105	Res, comp, 33Ω ±5%, 1W	4704-163063	01121	GB3305	1		
R106	Res, comp, 330Ω ±5%, 1W	4704-163394	01121	GB3315	1		
R107	Res, comp, 1M ±10%, 1/2W	4704-108134	01121	EB1051	2		L
R110	Res, var WW, 500Ω ±10%, 1-1/4W	4702-112433	71450	Type 110	1		
R111	Res, met flm, 23.2K ±1%, 1/2W	4705-159459	75042	Type CEC-TO	2		
R112	Res, met flm, 8.06K ±1%, 1/2W	4705-159467	75042	Type CEC-TO	2		
R113	Res, met flm, 10K ±1%, 1/2W	4705-151274	75042	Type CEC-TO	1		
R114	Res, met flm, 23.2K ±1%, 1/2W	4705-159459	75042	Type CEC-TO	REF		
R117	Res, comp, 10Ω ±10%, 1/2W	4704-108092	01121	EB1001	1		
R119	Res, var WW, 10Ω ±10%, 1-1/4W	4702-112672	71450	Type 110	1		

REF DESIG.	DESCRIPTION	FLUKE STOCK NO.	MFR.	MFR. PART NO.	TOT. QTY.	REC. QTY.	USE CODE
R121	Res, var WW, 25Ω ±10%, 1-1/4W	4702-161703	71450	Type 110	1		
R123	Res, var WW, 1K ±20%, 1-1/4W	4702-111575	71450	Type 110	3		
R124	Res, comp, 2.7K ±5%, 1/2W	4704-109074	01121	EB2725	1		
R125	Res, var WW, 1K ±20%, 1-1/4W	4702-111575	71450	Type 110	REF		
R126	Res, comp, 2.7K ±5%, 1/2W	4704-109074	01121	EB2725	1		
R127, R128	Res, comp, 4.7K ±10%, 1/2W	4704-108381	01121	EB4721	1		
R129, R130	Res, comp, 1K ±10%, 1/2W	4704-108563	01121	EB1021	5		
R131	Res, comp, 82Ω ±5%, 1/2W	4704-108746	01121	EB8205	1		N
R132	Res, comp, 2.7Ω ±10%, 1/2W	4704-108845	01121	EB27G1			O
	Res, comp, 8.2K ±5%, 1/2W	4704-147777	01121	EB8225	1		M
	Matched Zener-Res Set	3158-162792 (881A-413)	89536	3158-162792	1	1	
CR103, CR104	Diode, Zener	2			2		
R108	Res, WW, 8K, 1W	1			1		
R109	Res, WW, 16.5K to 20.4K, 1W	1			1		
R115	Res, WW, 25 to 180Ω, 1/8W	1					~ J
	Res, WW, selected, 1/2W	1			1		~ K
R116	Res, WW, 650Ω ±0.1%, 1/2W	1					~ J
R118	Res, WW, 6K to 10K, 1W	1			1		
	Matched Range-Divider Resistors	3158-192195 (881A-417)	89536	3158-192195			
R120	Res, WW, 49.488K, 1W	1			1		
R122	Res, WW, 6.111K, 1W	1			1		
	Matched Input-Divider Resistors	4710-159848 (881A-414)	89536	4710-159848	1	1	
R100 to R102	Res, WW, 3.3M, 1W	1	89536		3		
R104	Res, WW, 100.05K, 1/4W	1	89536		1		
	Polyethelene grommet, 3/8 x 1/4	2807-171876	89536	2807-171876	7		
	Polyethelene grommet, 1/2 x 3/8	2807-171884	89536	2807-171884	1		

1 These resistors are factory matched for each instrument. When ordering, include all information stamped on resistor.

2 If replacement is required, the entire Zener-Res Set must be replaced.

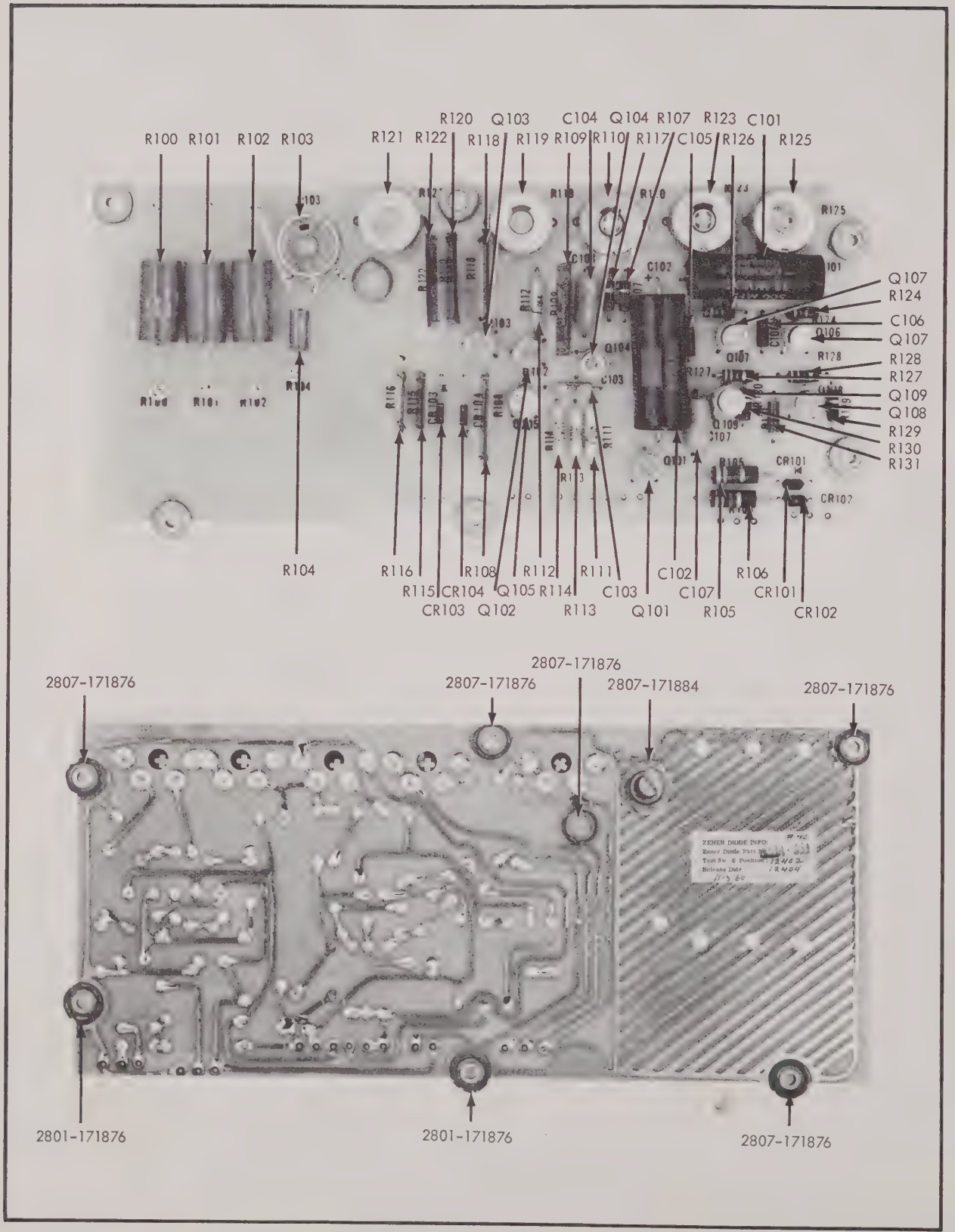


Figure 5-3. REFERENCE SUPPLY BOARD ASSEMBLY

REF DESIG.	DESCRIPTION	FLUKE STOCK NO.	MFR.	MFR. PART NO.	TOT. QTY.	REC. QTY.	USE CODE
	Null Detector Board Assembly	1702-163212 (881A-402)	89536	1702-163212	REF		
C201 to C203	Cap, plstc, .22 uf ±10%, 75V, coated with epoxy resin	1507-162768 (881A-238)	89536	1507-162768	3		
C204	Cap, plstc, 0.047 uf ±20%, 100V	1507-106096	84411	663UW47301	1		
C205	Cap, Al elect, 100 uf -10/+75%, 25V	1502-106518	56289	30D107G025DH4	3	1	
C206	Cap, Al elect, 40 uf -10/+75%, 6V	1502-105205	56289	30D406G006BB4	1	1	
C207	Cap, Al elect, 5 uf -10/+75%, 25V	1502-152009	56289	30D505G025BA4	2	1	
C208, C209	Cap, Al elect, 100 uf -10/+75%, 25V	1502-106518	56289	30D107G025DH4	REF		
C210	Cap, cer, 0.01 uf -20/+80%, 500V	1501-105668	56289	29C9B5	3		
C211	Cap, Al elect, 200 uf -10/+75%, 6V	1502-105189	56289	30D207G006DF4	1	1	
C212	Cap, plstc, 0.0047 uf ±20%, 200V	1507-106054	84411	663UW47202	1		
C213	Cap, Al elect, 20 uf -10/+75%, 50V	1502-106229	56289	30D206G050DC4	2	1	
C214	Cap, cer, 0.01 uf -20/+80%, 500V	1501-105668	56289	29C9B5	REF		
C215	Cap, Al elect, 500 uf -10/+75%, 3V	1502-106328	56289	30D507G003DH4	2	1	
C216	Cap, cer, 0.01 uf -20/+80%, 500V	1501-105668	56289	29C9B5	REF		
C217	Cap, Al elect, 5 uf -10/+75%, 25V	1502-152009	56289	30D505G025BA4	REF		
C218	Cap, Al elect, 20 uf -10/+75%, 50V	1502-106229	56289	30D206G050DC4	REF		
C219	Cap, Al elect, 500 uf -10/+75%, 3V	1502-106328	56289	30D507G003DH4	REF		
C220	Cap, Ta elect, 2.2 uf ±10%, 20V	1508-160226	05397	K2R2C20K	REF		
CR201, CR202	Diode, Si, 150 ma, 6 PIV	4802-113308	07910	CD13161	2	1	
DS201	Lamp, neon glow, type NE2E, 1/10W, coated with epoxy resin	3902-162776 (881A-239)	89536	3902-162776	1	1	
G201	Chopper, electromechanical, SPDT, coated with epoxy resin	5901-162784 (881A-240)	89536	5901-162784	1	1	N
	Chopper, electromechanical, SPDT	5901-218255	80640	CH1401/84	1	1	O
Q201	Tstr, field effect, P-channel (for replacement use 4805-216978)	4805-159210	17856	U-112	1	1	P
	Tstr, field effect, P-channel	4805-216978	89536	4805-216978	1	1	Q
Q202 to Q205	Tstr, Si, NPN (for replacement use 4805-203489)	4805-153551	07910	CDQ10449	REF		
Q206	Tstr, Ge, PNP	4805-116129	01295	2N1372	1	1	

REF DESIG.	DESCRIPTION	FLUKE STOCK NO.	MFR.	MFR. PART NO.	TOT. QTY.	REC. QTY.	USE CODE
R201	Res, comp, 220K ±10%, 2W	4704-110197	01121	HB2241	1		
R202, R203	Res, comp, 220K ±10%, 1/2W	4704-108217	01121	EB2241	2		
R204	Res, comp, 1M ±10%, 1/2W	4704-108134	01121	EB1051	REF		
R205	Res, comp, 22K ±10%, 1/2W	4704-108209	01121	EB2231	2		
R206	Res, comp, 1K ±10%, 1/2W	4704-108563	01121	EB1021	REF		
R207	Res, met flm, 8.06K ±1%, 1/2W	4705-159467	75042	Type CEC-TO	REF		
R208	Res, var WW, 5K ±5%, 2W	4702-111609	71450	Type 115	1		
R209	Res, comp, 10K ±10%, 1/2W	4704-108118	01121	EB1031	2		
R210	Res, comp, 1.8K ±10%, 1/2W	4704-108860	01121	EB1821	2		
R211	Res, comp, 47K ±10%, 1/2W	4704-108480	01121	EB4731	3		
R212	Res, comp, 1K ±10%, 1/2W	4704-108563	01121	EB1021	REF		
R213	Res, comp, 6.8K ±10%, 1/2W	4704-108399	01121	EB6821	1		
R214	Res, comp, 180Ω ±10%, 1/2W	4704-108571	01121	EB1811	1		
R215	Res, comp, 15K ±10%, 1/2W	4704-108530	01121	EB1531	1		
R216	Res, comp, 47K ±10%, 1/2W	4704-108480	01121	EB4731	REF		
R217	Res, comp, 9.1K ±5%, 1/2W	4704-160028	01121	EB9125	1		
R218	Res, comp, 27K ±10%, 1/2W	4704-108878	01121	EB2731	1		
R219	Res, comp, 1.8K ±10%, 1/2W	4704-108860	01121	EB1821	REF		
R220	Res, comp, 39Ω ±10%, 1/2W	4704-160036	01121	EB3901	1		
R221	Res, comp, 7.5K ±5%, 1/2W	4704-108910	01121	EB7525	1		
R222	Res, comp, 22K ±10%, 1/2W	4704-108209	01121	EB2231	REF		
R223	Res, comp, 10K ±10%, 1/2W	4704-108118	01121	EB1031	REF		
R224	Res, comp, 1K ±10%, 1/2W	4704-108563	01121	EB1021	REF		
R225	Res, comp, 3.9K ±10%, 1/2W	4704-161406	01121	EB3921	1		
R226, R227	Res, comp, 47K ±10%, 2W	4704-110015	01121	EB4731	REF		
R228	Res, comp, 1.5K ±10%, 1/2W	4704-108159	01121	EB1521	1		
R229	Res, met flm, 402Ω ±1%, 1/2W	4705-150839	75042	Type CEC-TO	1		P
	Res, met flm, 453Ω ±1%, 1/2W	4705-155051	75042	Type CEC-TO	1		Q
R230	Res, var WW, 100Ω ±20%, 1-1/4W	4702-112797	71450	Type 110	1		

REF DESIG.	DESCRIPTION	FLUKE STOCK NO.	MFR.	MFR. PART NO.	TOT. QTY.	REC. QTY.	USE CODE
R231	Res, var WW, 5K ±5%, 2W (use 4702-112862)	4702-111609	71450	Type 115	1	1	D
	Res, var WW, 10K ±5%, 2W	4702-112862	71450	Type 110	1		E
R232	Res, met flm, 90.9K ±1%, 1/2W	4705-162974	75042	Type CEC-TO	1		
R233	Res, met flm, 909K ±1%, 1/2W	4705-159483	75042	Type CEC-TO	1		
R234	Res, met flm, 1K ±1%, 1/2W	4705-151324	72982	Type MF7C-TO	REF		
R235	Res, met flm, 8.45K ±1%, 1/2W	4705-159475	75042	Type CEC-TO	1		
R236	Res, met flm, 200Ω ±1%, 1/2W	4705-151480	75042	Type CEC-TO	1		
R237	Res, comp, 6.8M ±10%, 1/2W	4704-108662	01121	EB6851	1		
R238	Res, comp, 56K ±10%, 1/2W	4704-108472	01121	EB5631	1		
R239	Res, var comp, 100K ±30%, 3/10W	4701-163402	71450	Type 70	1		
R240	Res, comp, 180K ±10%, 1/2W	4704-108431	01121	EB1841	1		
	Polyethylene grommet, 3/8 x 1/4	2807-171876	89536	2807-171876	6		

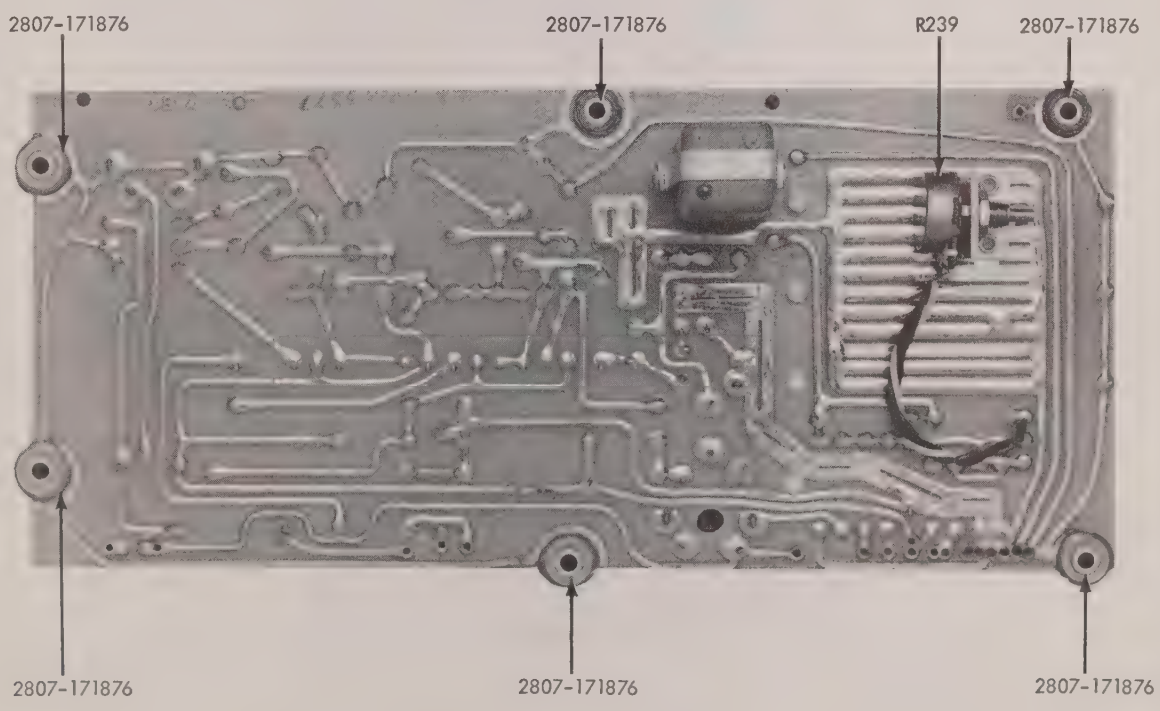


Figure 5-4. NULL DETECTOR BOARD ASSEMBLY (sheet 1 of 2)

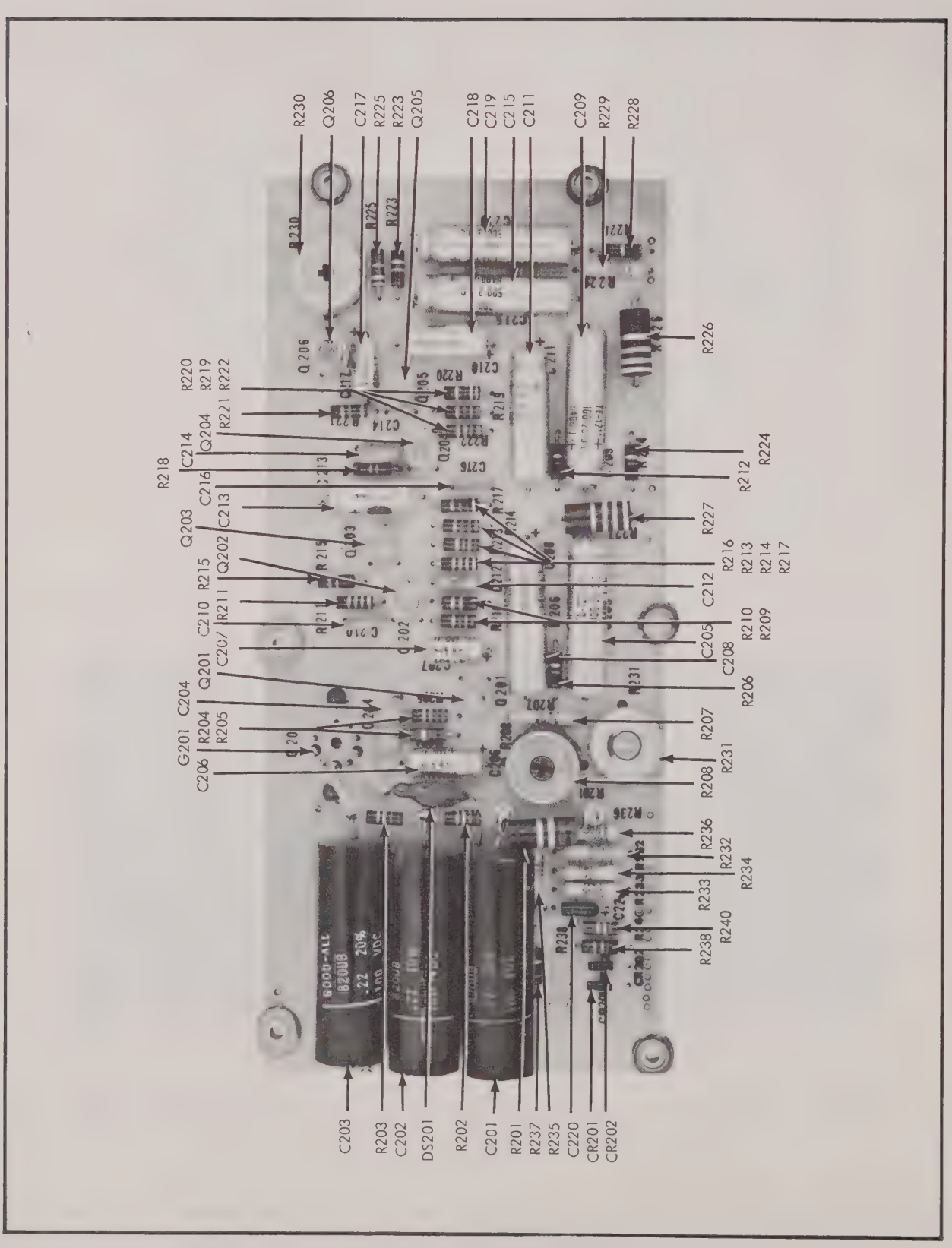


Figure 5-4. NULL DETECTOR BOARD ASSEMBLY (sheet 2 of 2)

REF DESIG.	DESCRIPTION	FLUKE STOCK NO.	MFR.	MFR. PART NO.	TOT. QTY.	REC. QTY.	USE CODE
	Kelvin-Varley Assembly	5111-162495 (881A-404)	89536	5111-162495	REF		
C301	Cap, plstc, 1 uf ±20%, 200V	1507-106450	84411	Type X663F	1		
R12	Res, var WW, 2.5K ±1%, 0.75% linear	4711-163154 (881A-401)	89536	4711-163154	1		
R302	Res, met flm, 9.53K ±1%, 1/2W	4705-159442	75042	Type CEC-TO	1		
R303	Res, var WW, 1K ±20%, 1-1/4W	4702-111575	71450	Type 110	REF		
R304 to R314	Res, WW, 1K, 1/2W	1	89536		33		
R315	Res, WW, 2,499Ω, 1/2W	1	89536		2		
R316	Res, var WW, 2Ω ±10%, 2W	4702-153445	71450	Type 115	9		
R317 to R327	Res, WW, 1K, 1/2W	1	89536				
R328	Res, WW, 2,499Ω, 1/2W	1	89536				
R329	Res, var WW, 2Ω ±10%, 2W	4702-153445	71450	Type 115	REF		
R330 to R340	Res, WW, 1K, 1/2W	1	89536				
Odd no. from R341 to R363	Res, WW, 4,999.2Ω ±0.01%, 1W	1	89536		12		
Even no.from R342 to R354	Res, var WW, 2Ω ±10%, 2W	4702-153445	71450	Type 115	REF		
Even no.from R356 to R364	Res, var WW, 2Ω ±10%, 2W (use 4702-182410)	4702-153445	89536	Type 115	-		~F
	Res, var WW, 2Ω ±10%, 2W	4702-182410	89536	4702-182410	5		~G
S5	Sw, voltage dial A	5105-162644 (881A-809)	89536	5105-162644	1		
S6	Sw, voltage dial B	5105-162636 (881A-810)	89536	5105-162636	2		
S7	Sw, voltage dial C	5105-162651 (881A-811)	89536	5105-162651	1		
S8	Sw, voltage dial D	5105-162636 (881A-810)	89536	5105-162636	REF		
	Polyethelene grommet 3/8 x 1/4	2807-171876	89536	2807-171876	4		

1 These resistors are factory matched for each instrument. When ordering, include all information stamped on resistor.

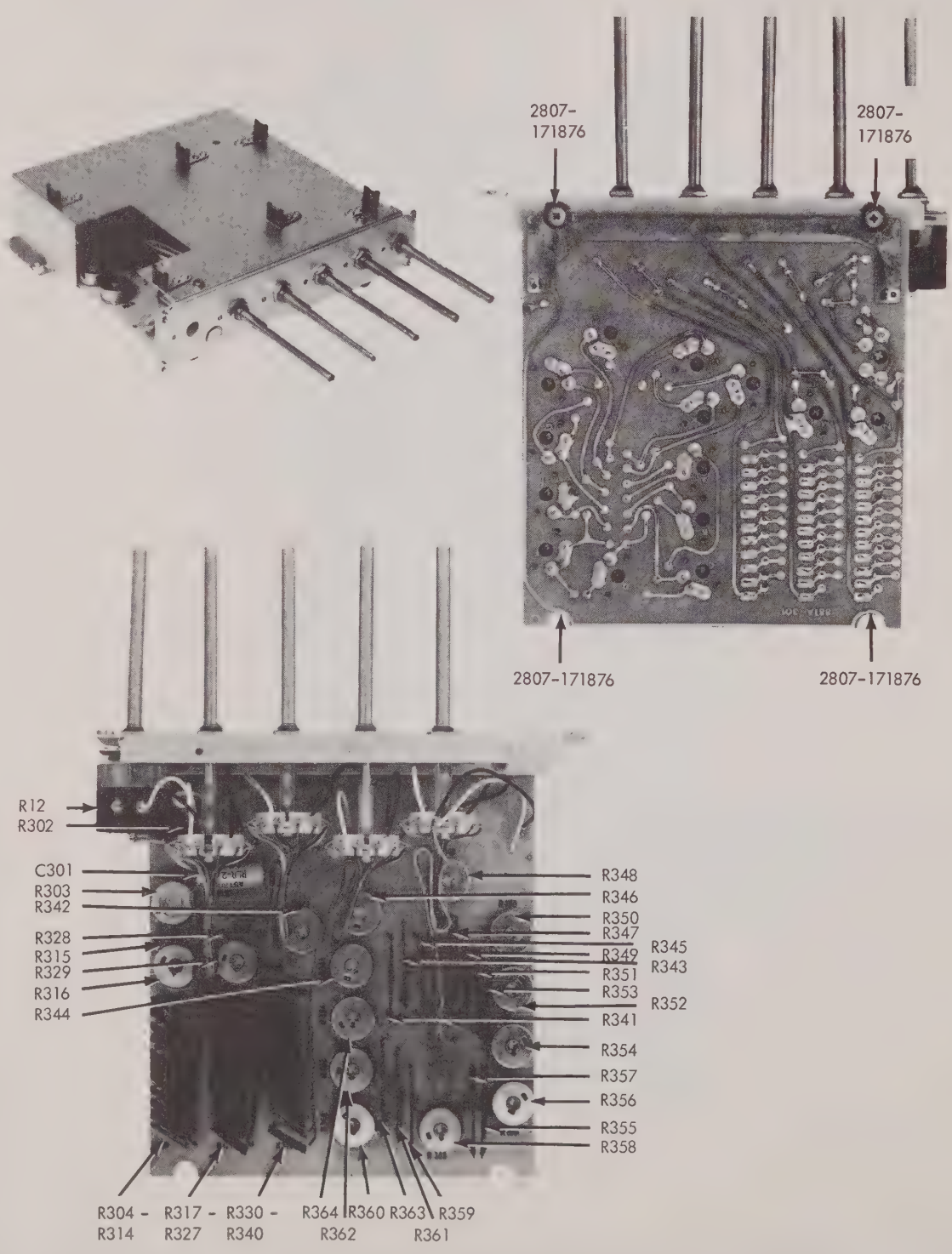


Figure 5-5. KELVIN-VARLEY ASSEMBLY

5-11. USE CODE EFFECTIVITY

The following list of use codes is intended to allow the customer to determine the effectivity of all replaceable parts. All parts with no code are used on all instruments with serial numbers above 123. New codes will be added as necessary on forthcoming instruments.

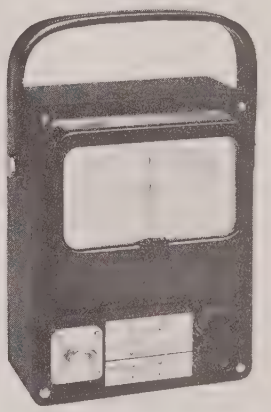
USE CODE	EFFECTIVITY
No Code	Model 881A & 881AB serial number 123 and on
A	Model 881A & 881AB serial number 123 thru 200
B	Model 881A & 881AB serial number 201 and on
C	Model 881A & 881AB serial number 123 thru 151
D	Model 881A & 881AB serial number 123 thru 144
E	Model 881A & 881AB serial number 145 and on
F	Model 881A & 881AB serial number 123 thru 205
G	Model 881A & 881AB serial number 206 and on
H	Model 881A & 881AB serial number 123 thru 290
I	Model 881A & 881AB serial number 291 and on
J	Model 881A & 881AB serial number 123 thru 329
K	Model 881A & 881AB serial number 330 and on
L	Model 881A & 881AB serial number 123 thru 405
M	Model 881A & 881AB serial number 406 and on
N	Model 881A & 881AB serial number 123 to 569
O	Model 881A & 881AB serial number 570 and on
P	Model 881A & 881AB serial number 123 to 445
Q	Model 881A & 881AB serial number 446 and on

SECTION VI

ACCESSORIES

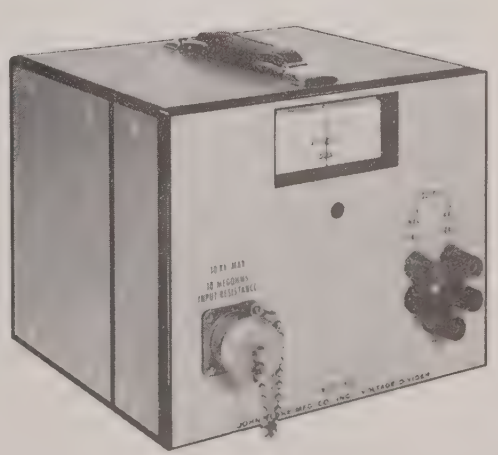
6-1. PRECISION VOLTAGE DIVIDERS

6-2. The FLUKE 80A, 80D, and 80E Voltage Dividers provide the FLUKE 800 Series Differential Voltmeters with the ability to make high accuracy measurements up to 30,000 volts DC. All models contain a zero center panel meter which allows the polarity and approximate magnitude of the unknown high voltage to be easily observed. At maximum input, all units draw but 1 ma of current from the unknown. The extreme accuracy and excellent long term stability of these dividers are obtained by using properly aged precision wirewound resistors which have a very low temperature coefficient. To further ensure high accuracy and long term stability at very high voltages, the 80D dividers have all resistance components immersed in oil within a hermetically sealed container. As an additional feature, all 80D and 80E models are provided with a 1 volt tap which allows measurements of high voltages with a laboratory potentiometer. Specifications for the standard models are shown on next page. Other intermediate models are available upon special request.



MODEL 80A

MODEL 80D



MODEL 80E

Model No.	Maximum Input Voltage	Total Resistance	Current Drawn At Max. Input	Division Ratio			Division Ratio Accuracy	Stability of Division Accuracy Per Year
				500V Out	10V Out	1V Out		
80A-1 80A-2	1 KV 2 KV	1 M 2 M	1 ma 1 ma	2:1 4:1	—— ——	—— ——	±0.015% ±0.015%	—— ——
80E-5 80E-10	5 KV 10 KV	5 M 10 M	1 ma 1 ma	— —	500:1 1000:1	5,000:1 10,000:1	±0.01% ±0.01%	±0.01% ±0.01%
80D-30	30 KV	30 M	1 ma	60:1	3000:1	30,000:1	±0.01%	±0.01%

MODELS	SIZE	INPUT CONNECTOR	OUTPUT CONNECTOR
80A	6-3/4" high 5-1/4" wide 2-1/4" deep	UG-560U with mating connector supplied	Insulated binding posts on 3/4" centers
80E	7" high 8-1/2" wide 8" deep	MS3102A-18-165 with mating connector supplied	Insulated binding posts on 3/4" centers for both outputs
80D	13" high 9-3/4" wide 16" deep	Special 5" ceramic standoff with mating 6" guard supplied	Insulated binding post on 3/4" centers for both outputs

MODEL A88 ISOLATION AMPLIFIER

6-3. ISOLATION AMPLIFIER

6-4. The FLUKE Model A88 all solid-state isolation amplifier is designed to provide isolation between the output of a differential voltmeter and the input of a recorder. Thus, the A88 will allow the use of a wide range of strip chart recorders for recording the voltmeter reading without regard to the input isolation characteristics of the recorder. The A88 is also excellent for making accurate dc microvolt and nanoampere measurements in the presents of common mode voltages up to 1100 vdc and 3 vac, 50 to 500 cycles.

GAIN: 1 volt output per microampere input.

GAIN ACCURACY: ±2%.

INPUT CURRENT RANGE: 0 to 2 microamperes.

INPUT VOLTAGE RANGE: 0 to 2 millivolts nominal.

INPUT RESISTANCE: 950 ohms (±5%).

OUTPUT VOLTAGE RANGE: 0 to 2 volts open circuit.

OUTPUT RESISTANCE: 1000 ohms (±5%).

INPUT ISOLATION FROM CHASSES: Greater than 5×10^{11} ohms at 25°C (77°F), 60% RH and 1×10^{10} ohms at 50°C (122°F), 80% RH.

ACCESSORY INFORMATION

MODEL A90 CURRENT SHUNT

6-1. INTRODUCTION

6-2. The Model A90 Current Shunt is designed for use with any high-impedance ac or dc voltmeter capable of accurately measuring 100 millivolts. Six Fluke precision wire wound and strip resistors provide a 100 millivolt full-scale output for each of six pushbutton current ranges: 0.1, 1, 10, 100, and 1000 milliamperes and 10 amperes (ac or dc). Basic accuracy is specified over a frequency range of dc to 4 kHz for the 10 ampere range and dc to 10 kHz for the milliampere ranges.

6-3. The instrument is supplied in half-rack case so that it may be conveniently mounted side-by-side with other half-rack instruments in a standard 19-inch rack. A carrying handle detents into custom non-marring feet and serves as a tilt-up bail for bench use.

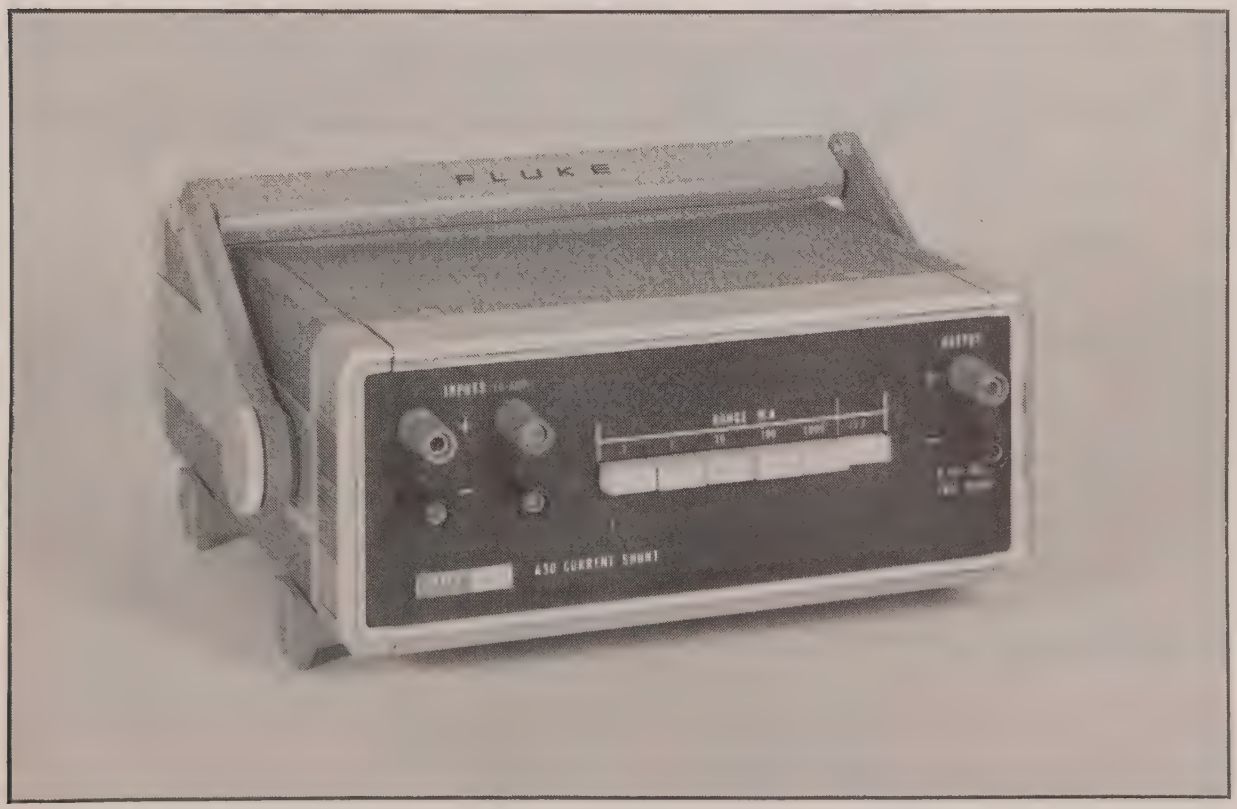
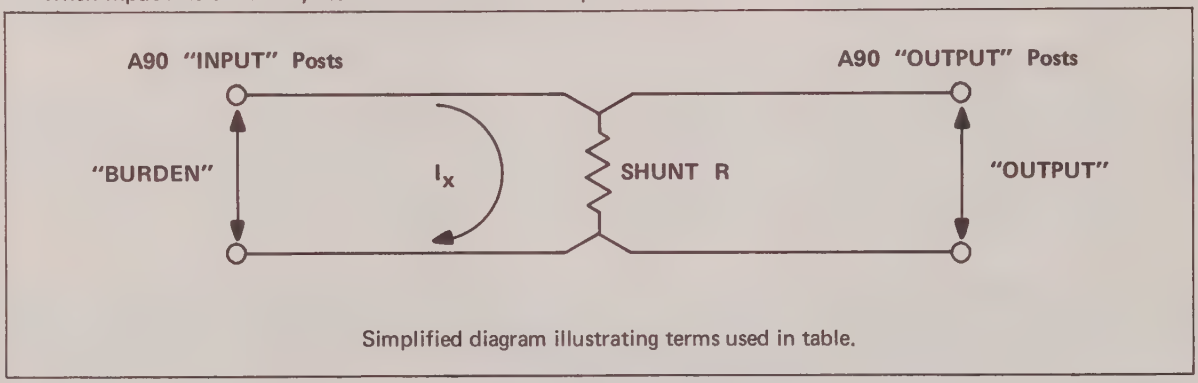


Figure 6-1. MODEL A90 CURRENT SHUNT

Table 6-1. ACCURACY OF A90 (1 year, 15°C - 35°C)

RATED CURRENT RANGE	E BURDEN (APPROX.)	SHUNT R	"OUTPUT" AT RATED CURRENT	"OUTPUT" ACCURACY AS % OF CURRENT INPUT	
				DC ONLY	DC TO 10 KHZ AC
0.1 ma	100 mv	1 kΩ	100 mv	±0.1%	±0.1%
* 0.1 ma	100 mv	1 kΩ	100 mv	+0.0% –0.2%	+0.0% –0.2%
1.0 ma	100 mv	100Ω	100 mv	±0.1%	±0.1%
10 ma	100 mv	10Ω	100 mv	±0.1%	±0.1%
100 ma	102 mv	1Ω	100 mv	±0.1%	±0.1%
1A	120 mv	0.1Ω	100 mv	±0.1%	±0.2%
10A	300 mv	0.01Ω	100 mv	±0.2%	±0.3% (to 4 kHz)

* With 1 MΩ Input R Voltmeter.
When Input R is ⩾10 MΩ, use non-asterisked 0.1 ma specification.



Simplified diagram illustrating terms used in table.

6-4. SPECIFICATIONS

6-5. Electrical

RANGE
0.1, 1, 10, 100, and 1000 milliamps and 10 amperes.

ACCURACY
Table 6-1 gives accuracy specifications for the Model A90 only. Total current measurement accuracy is also dependent on the accuracy and input impedance of the voltmeter being used.

SENSITIVITY
100 millivolts full scale.

OVERLOAD
Model A90 will not be damaged by 100% overload on each range below 10 amperes or by 50% overload on the 10 ampere range.

6-6. Mechanical

CURRENT SELECTION
Pushbutton, each range.

CONNECTORS
Positive (+) and negative (–) INPUT and OUTPUT binding posts with separate input posts for 10 ampere range.

DIMENSIONS
The Model A90 outline drawing is shown in Figure 6-2.

RACK MOUNTING KITS (OPTIONAL)
MEE-7014: Side-by-side Half-rack Mounting Kit
MEE-7006: Center Rack Mounting Kit
MEE-7013: Left or right of center Mounting Kit.

6-7. AUXILIARY ELECTRICAL SPECIFICATIONS

6-8. Tables 6-2 through 6-6 provide accuracy specifications for the Model A90 when used with Fluke Models

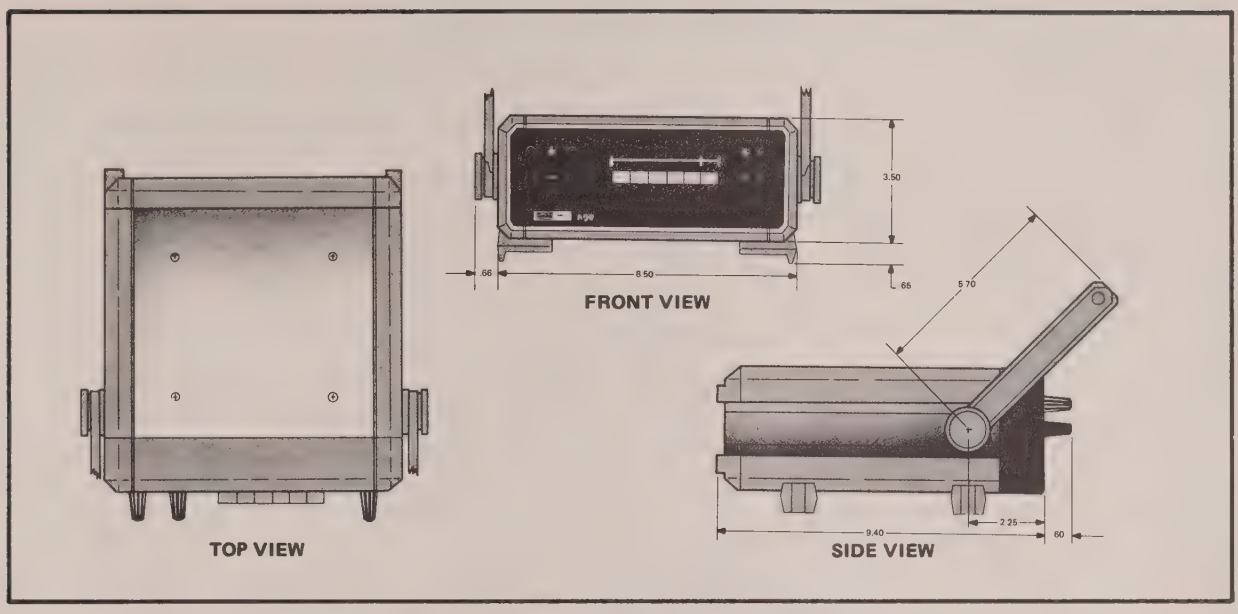


Figure 6-2. MODEL A90 OUTLINE DRAWING

Table 6-2. A90/8100A ACCURACY. 30 days, @ 23°C ±5°C.

DC ACCURACY	
CURRENT RANGE	SPECIFICATION
0.1 ma	±(0.12% of current input + 0.1 ua)
1.0 ma	±(0.12% of current input + 1.0 ua)
10 ma	±(0.12% of current input + 10 ua)
100 ma	±(0.12% of current input + 0.1 ma)
1A	±(0.12% of current input + 1.0 ma)
10A	±(0.22% of current input + 10 ma)

AC ACCURACY		
CURRENT RANGE	30 Hz – 50 Hz	50 Hz – 10 kHz
0.1 ma	+(0.5% of current input + 1.0 ua) –(0.7% of current input + 1.0 ua)	+(0.2% of current input + 0.5 ua) –(0.4% of current input + 0.5 ua)
1.0 ma	±(0.6% of current input + 10 ua)	±(0.3% of current input + 5.0 ua)
10 ma	±(0.6% of current input + 0.1 ma)	±(0.3% of current input + 50 ua)
100 ma	±(0.6% of current input + 1.0 ma)	±(0.3% of current input + 0.5 ma)
1A	±(0.7% of current input + 10 ma)	±(0.4% of current input + 5.0 ma)
10A	±(0.8% of current input + 100 ma)	±(0.5% of current input + 50 ma)*

*10A specified to 4 kHz only.

For:	DC CURRENT	AC CURRENT
	V_r = 1v	V_r = 1v
	V_{dfs} = ±.1000	V_{dfs} = .1000

Table 6-3. A90/8300A ACCURACY

DC CURRENT ACCURACY

MEASUREMENTS WITHOUT MV/OHMS OPTION INSTALLED

CURRENT RANGE	24 hr @ 23°C ±1°C	90 days @ 23°C ±5°C
0.1 ma	±(0.1% of current input + 0.1 ua)	±(0.11% of current input + 0.3 ua)
1.0 ma	±(0.1% of current input + 1.0 ua)	±(0.11% of current input + 3.0 ua)
10 ma	±(0.1% of current input + 10 ua)	±(0.11% of current input + 30 ua)
100 ma	±(0.1% of current input + 0.1 ma)	±(0.11% of current input + 0.3 ma)
1A	±(0.1% of current input + 1.0 ma)	±(0.11% of current input + 3.0 ma)
10A	±(0.2% of current input + 10 ma)	±(0.21% of current input + 30 ma)

V_r = 10 VDC

V_{dfs} = 0.1000 (Readout also will display "DC +" or "DC –").

MEASUREMENTS WITH MV/OHMS OPTION (8300A-02) INSTALLED

CURRENT RANGE	90 days @ 23°C ±5°C
0.1 ma	±(0.11% of current input + 0.01 ua)
1.0 ma	±(0.11% of current input + 0.1 ua)
10 ma	±(0.11% of current input + 1.0 ua)
100 ma	±(0.11% of current input + 10 ua)
1A	±(0.11% of current input + 0.1 ma)
10A	±(0.21% of current input + 1.0 ma)

V_r = 100 MV (0.1v)

V_{dfs} = 100.000 (Readout will also display MV DC + or MV DC–)

AC CURRENT ACCURACY

MEASUREMENTS WITH AC OPTION 8300A-01 INSTALLED

90 days @ 23°C ±5°C using AC Zero control periodically.

CURRENT RANGE	30 Hz – 50 Hz	50 Hz – 10 kHz
0.1 ma	+(0.5% of current input + 0.05 ua) –(0.7% of current input + 0.05 ua)	+(0.1% of current input + 0.05 ua) –(0.3% of current input + 0.05 ua)
1.0 ma	±(0.6% of current input + 0.5 ua)	±(0.2% of current input + 0.5 ua)
10 ma	±(0.6% of current input + 5.0 ua)	±(0.2% of current input + 5.0 ua)
100 ma	±(0.6% of current input + 50 ua)	±(0.2% of current input + 50 ua)
1A	±(0.7% of current input + 0.5 ma)	±(0.3% of current input + 0.5 ma)
10A	±(0.8% of current input + 5.0 ma)	±(0.4% of current input + 5.0 ma)*

V_r = 1 VAC

V_{dfs} = .10000 (Readout will also display "AC")

*10A specified to 4 kHz only.

Table 6-4. A90/9500A SPECIFICATIONS

ACCURACY WHEN UNKNOWN CURRENT IS 20% OR MORE OF A90 CURRENT RANGE. (23°C ±1°C)

CURRENT RANGE	20 Hz – 50 Hz	50 Hz – 10 kHz
0.1 ma	+(0.3% of current input + 0.02 ua) –(0.5% of current input + 0.02 ua)	+(0.05% of current input + 0.015 ua) –(0.25% of current input + 0.015 ua)
1.0 ma	±(0.4% of current input + 0.2 ua)	±(0.15% of current input + 0.15 ua)
10 ma	±(0.4% of current input + 2.0 ua)	±(0.15% of current input + 1.5 ua)
100 ma	±(0.4% of current input + 20 ua)	±(0.15% of current input + 15 ua)
1A	±(0.5% of current input + 0.2 ma)	±(0.25% of current input + 0.15 ma)
10A	±(0.6% of current input + 2.0 ma)	±(0.35% of current input + 1.5 ma)*

ACCURACY WHEN UNKNOWN CURRENT IS BETWEEN 10% AND 20% OF A90 CURRENT RANGE.

A90 INPUT (% OF CURRENT RANGE)	% OF INPUT ABSOLUTE ACCURACY 20 Hz – 50 Hz @ 23°C ±1°C FOR A90 CURRENT RANGE				
	0.1 ma				
	+	–	1 ma – 100 ma	1A	10A
10-11%	0.53%	0.73%	± 0.63%	±0.73%	±0.83%
12-14%	0.50%	0.70%	± 0.60%	±0.70%	±0.80%
15-17%	0.47%	0.67%	± 0.57%	±0.67%	±0.77%
18-20%	0.44%	0.64%	± 0.54%	±0.64%	±0.74%

A90 INPUT (% OF CURRENT RANGE)	% OF INPUT ABSOLUTE ACCURACY 50 Hz – 10 kHz @23°C ±1°C FOR A90 CURRENT RANGE				
	0.1 ma				
	+	–	1 ma – 100 ma	1A	10A*
10-11%	0.23%	0.43%	±0.33%	±0.43%	±0.53%
12-14%	0.20%	0.40%	±0.30%	±0.40%	±0.50%
15-17%	0.17%	0.37%	±0.27%	±0.37%	±0.47%
18-20%	0.13%	0.33%	±0.23%	±0.33%	±0.43%

V_r = .1v

V_{dfs} = .10000

TC = 0.005% of current input/°C 20 Hz –50 Hz
0.004% of current input/°C 50 Hz – 10 kHz

*10A is specified to 4 kHz only.

8100A, 8300A, 9500A, 891A, 893A, and 931B. Table 6-7 gives V_r and V_{dfs} for each of the voltmeters listed in the tables in addition to various other Fluke voltmeters, where

V_r = Voltage range to be used on the voltmeter
and V_{dfs} = Nominal voltmeter reading with full-scale current in A90 shunt.

6-9. INSTALLATION

6-10. There are three rack-mount kits available, at additional cost, for use with the Model A90. Kit MEE-7014 allows the Model A90 to be mounted side-by-side with another half-rack instrument in a standard 19-inch rack. Kit MEE-7006 supplies hardware necessary to mount the

Table 6-5. A90/891A AND 893A ACCURACY (Sheet 1 of 2)

WITH 891A AND 893A – DC ACCURACY

CURRENT RANGE	@ 23°C ±2°C	@ 15°C –35°C
0.1 ma	±(0.11% of current input + 0.02 ua)	±(0.12% of current input + 0.02 ua)
1.0 ma	±(0.11% of current input + 0.2 ua)	±(0.12% of current input + 0.2 ua)
10 ma	±(0.11% of current input + 2.0 ua)	±(0.12% of current input + 2.0 ua)
100 ma	±(0.11% of current input + 20 ua)	±(0.12% of current input + 20 ua)
1A	±(0.11% of current input + 0.2 ma)	±(0.12% of current input + 0.2 ma)
10A	±(0.21% of current input + 2.0 ma)	±(0.22% of current input + 2.0 ma)

V_r = 1v

V_{dfs} = 0.10000

WITH 893A – AC ACCURACY
@ 23°C ±2°C

CURRENT RANGE	50 Hz – 10 kHz
0.1 ma	+(0.05% of current input + 0.025 ua) –(0.25% of current input + 0.025 ua)
1.0 ma	±(0.15% of current input + 0.25 ua)
10 ma	±(0.15% of current input + 2.5 ua)
100 ma	±(0.15% of current input + 25 ua)
1A	±(0.25% of current input + 0.25 ma)
10A	±(0.35% of current input + 2.5 ma)*

WITH 893A – AC ACCURACY
@ 15°C –35°C

CURRENT RANGE	5 Hz – 10 Hz	10 Hz – 20 Hz
0.1 ma	+(1.0% of current input + 0.25 ua) –(1.2% of current input + 0.25 ua)	+(0.5% of current input + 0.1 ua) –(0.7% of current input + 0.1 ua)
1.0 ma	±(1.1% of current input + 2.5 ua)	±(0.6% of current input + 1.0 ua)
10 ma	±(1.1% of current input + 25 ua)	±(0.6% of current input ± 10 ua)
100 ma	±(1.1% of current input + 0.25 ua)	+(0.6% of current input + 0.1 ma)
1A	±(1.2% of current input + 2.5 ma)	±(0.7% of current input + 1.0 ma)
10A	±(1.3% of current input + 25 ma)	±(0.8% of current input + 10 ma)

893A – AC ACCURACY
@ 15°C –35°C.

CURRENT RANGE	20 Hz – 50 Hz	50 Hz – 10 kHz
0.1 ma	+(0.15% of current input + 0.025 ua) –(0.35% of current input + 0.025 ua)	+(0.1% of current input + 0.025 ua) –(0.3% of current input + 0.025 ua)
1.0 ma	±(0.25% of current input + 0.25 ua)	±(0.2% of current input + 0.25 ua)
10 ma	±(0.25% of current input + 2.5 ua)	±(0.2% of current input + 2.5 ua)
100 ma	±(0.25% of current input + 25 ua)	±(0.2% of current input + 25 ua)
1A	±(0.35% of current input + 0.25 ma)	±(0.3% of current input + 0.25 ma)
10A	±(0.45% of current input + 2.5 ma)	±(0.4% of current input + 2.5 ma)*

Table 6-5. A90/891A AND 893A ACCURACY (Sheet 2 of 2)

	V_r =	1v (AC or DC)
	V_{dfs} =	0.10000

*10A is specified to 4 kHz only.

Table 6-6. A90/931B SPECIFICATIONS

ACCURACY WHEN UNKNOWN CURRENT IS 10% OR MORE OF A90 CURRENT RANGE				
CURRENT RANGE	% OF INPUT ABSOLUTE ACCURACY 2 Hz – 3 Hz	3 Hz – 5 Hz	5 Hz – 30 Hz	SPECIFICATIONS 30 Hz – 10 kHz
0.1 ma	+1.0% –1.2%	+0.5% –0.7%	+0.2% –0.4%	+(0.05% of current input + 5 na) –(0.25% of current input + 5 na)
1.0 ma	±1.1%	±0.6%	±0.3%	±(0.15% of current input + 50 na)
10 ma	±1.1%	±0.6%	±0.3%	±(0.15% of current input + 0.5 ua)
100 ma	±1.1%	±0.6%	±0.3%	±(0.15% of current input + 5 ua)
1A	±1.2%	±0.7%	±0.4%	±(0.25% of current input + 50 ua)
10A	±1.3%	±0.8%	±0.5%	±(0.35% of current input + 0.5 ma)*
TC=	±0.1%/°C	±0.05%/°C	±0.025%/°C	±0.0025%/°C

V_r = 100 MV
V_{dfs} = 100.000

*10A is specified to 4 kHz only.

Table 6-7. "V_r" AND "V_{dfs}" FOR VOLTMETERS OF TABLES 6-2 THROUGH 6-6

VOLTMETER	"V_r"	"V_{dfs}"
8300A (Without MV/Ohms)	10v	.010
8100A, 871A, 873A, 881A, 883A, 885A, 887A, 891A, 893A	1v	.100
801, 803, 801B, 803B, 803D, 821A, 823A, 825A	0.5v	.100
9500A, 910A	0.1v	.100
8300A (With MV/Ohms), 931A, 931B	100 MV	100.0

V_r = Voltage range to be used on the voltmeter.
V_{dfs} = Nominal voltmeter reading with full-scale current in A90 shunt.

instrument in the center of the rack. Kit MEE-7013 supplies two different sized rack ears so that the instrument can be mounted to the left or to the right of rack center.

6-11. OPERATING INSTRUCTIONS

6-12. A description of Model A90 controls and terminals is given in Figure 6-3.

6-13. Equipment Connections

6-14. It is recommended that the Model A90 always be used in the "LO" lead as shown in Figure 6-4A. When used in the "HI" lead, as shown in Figure 6-4B, the distributed capacitance, C_{DIST}, loads the source. When connected in the "HI" lead, the voltmeter guard should either be connected as shown or else the voltmeter should be battery operated.

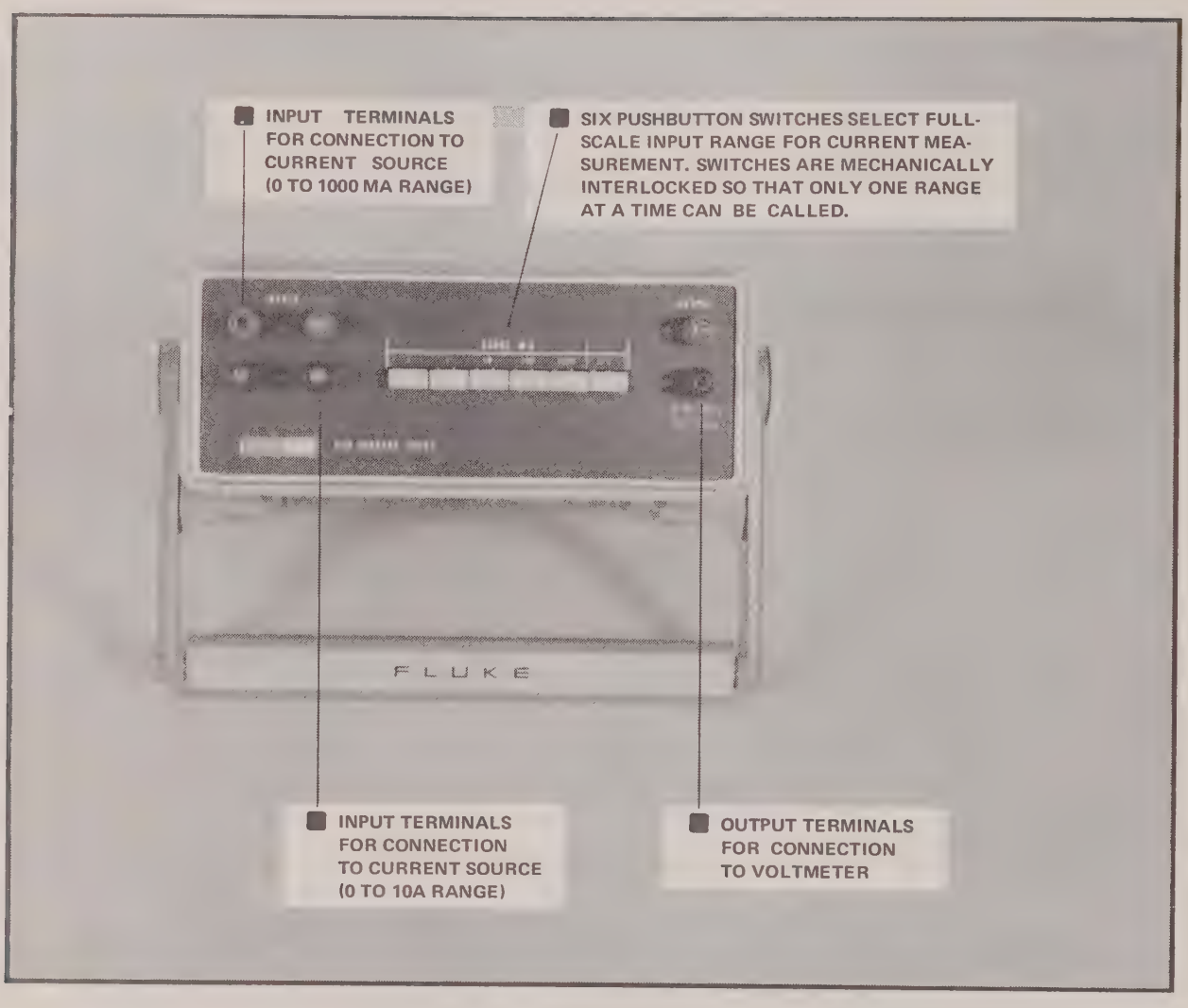

INPUT TERMINALS FOR CONNECTION TO CURRENT SOURCE (0 TO 1000 MA RANGE)
SIX PUSHBUTTON SWITCHES SELECT FULL-SCALE INPUT RANGE FOR CURRENT MEASUREMENT. SWITCHES ARE MECHANICALLY INTERLOCKED SO THAT ONLY ONE RANGE AT A TIME CAN BE CALLED.
FLUKE
INPUT TERMINALS FOR CONNECTION TO CURRENT SOURCE (0 TO 10A RANGE)
OUTPUT TERMINALS FOR CONNECTION TO VOLTMETER

Figure 6-3. MODEL A90 CONTROLS AND TERMINALS.

6-15. At high ac currents, performance of the A90 may depend upon the manner in which the current leads are connected to the input binding posts. Optimum performance is obtained when the input current leads are twisted.

6-16. Voltmeter Impedance

6-17. The input impedance of the voltmeter which is used with the Model A90 is significant with regard to total measurement accuracy. As indicated in the specifications, Model A90 measurement accuracy is derated for voltmeters having finite input impedance. As the voltmeter input capacity increases, the Model A90 response rolls off at the high end; and as the voltmeter input resistance decreases, the response shifts downward, resulting in negative measurement errors.

6-18. Combining Model A90 And Voltmeter Specifications

6-19. Combined specifications for the A90 when used with various Fluke voltmeters is given in Tables 6-2 through 6-6. When the A90 is used with other voltmeters, the following information may be used to combine specifications.

6-20. Equation 1 (Figure 6-5) is used to combine A90 and voltmeter specifications for overall accuracy. The "W" term is taken from Table 6-1, and the "X", "Y" and "Z" terms are taken from voltmeter specifications (data sheets). All Fluke voltmeter specifications, except the Model 910A, contain the "X" term; they usually list the "Y" term and occasionally the "Z" term. Model 910A accuracy specifi-

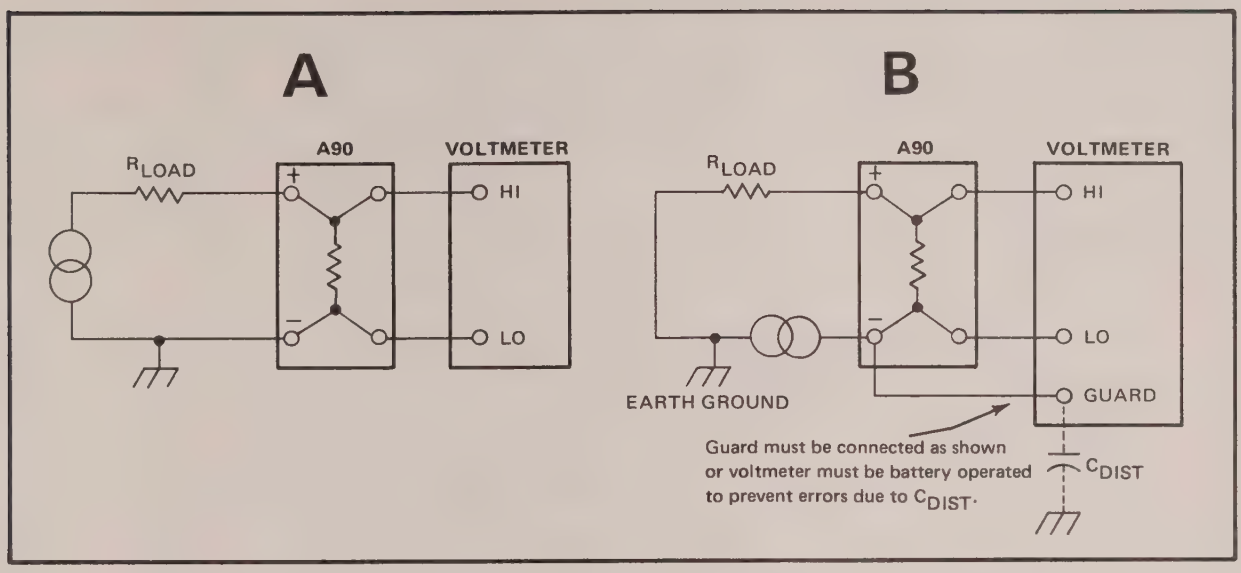


Figure 6-4. EQUIPMENT CONNECTIONS FOR CURRENT MEASUREMENT.

EQUATION 1. COMBINING A-90 SPECIFICATION WITH VOLTMETER SPECIFICATION.

A-90 Specification (from Table 6-1)

Voltmeter Specification (from Voltmeter Data Sheet)

$$\pm \left| W \right| \% \qquad \pm \left(\left| X \right| \% \text{ of input} + \left| Y \right| \% \text{ of range} + \left| Z \right| \text{ uv} \right)$$

Vr = Lowest voltmeter range that will measure 100 MV

$$= + \left[\left(W + X \right) \% \text{ of current input} + \frac{Vr}{0.1} \times \left(Y + \frac{Z}{10000} \right) \% \text{ of current range} \right]$$

EXAMPLE 1: Accuracy using 10 ma DC A-90 range with 891A.

A-90 Specification (from Table 6-1)

891A Specification (from 891A Data Sheet)

$$\pm \left| 0.1 \right| \% \qquad \pm \left(\left| 0.01 \right| \% \text{ of input} + \left| 0.001 \right| \% \text{ of range} + \left| 10 \right| \text{ uv} \right)$$

Vr = 1.0 (891A's 1v DC Range)

$$= \pm \left[(0.1 + 0.01) \% \text{ of current input} + \frac{1.0}{0.1} \times \left(0.001 + \frac{10}{10{,}000} \right) \% \text{ of current range} \right]$$

$$= \pm \left[0.11\% \text{ of current input} + 0.02\% \text{ of current range} \right]$$

$$= \pm \left[0.11\% \text{ of current input} + 2 \text{ ua} \right]$$

Figure 6-5. EQUATION 1 – COMBINING A90 AND VOLTMETER SPECIFICATIONS (Sheet 1 of 2)

EXAMPLE 2: Accuracy using 0.1 ma AC A-90 range with 873A at 1 kHz.

Model 873A has 1 megohm input impedance in its AC mode so separate accuracy statements are required for positive and negative limits of error for measurements made on the A-90's 0.1 ma range.

Positive Limit of Error

A-90 Specification: + | 0.0 | %

873A Specification: ± | 0.2 | % of input + | 25 | uv

"Vr" is 873A's 1v AC Range

No "Y" Term In Spec.

$$= +\left[(0.0 + 0.2)\ \%\ \text{of current input} + \frac{1}{0.1} \times \left(0 + \frac{25}{10000}\right)\ \%\ \text{of current range}\right]$$

$$= +\left[\ 0.2\%\ \text{of current input} + 0.025\%\ \text{of current range}\ \right]$$

Negative Limit of Error

$$= -\left[\ (0.2 + 0.2)\ \%\ \text{of current input} + 0.025\%\ \text{of current range}\ \right]$$

$$= -\left[\ 0.4\%\ \text{of current input} + 0.025\%\ \text{of current range.}\ \right]$$

Figure 6-5. EQUATION 1 – COMBINING A90 AND VOLTMETER SPECIFICATIONS (Sheet 2 of 2)

cation consists of "Y" term only. If "X", "Y", or "Z" do not appear in a voltmeter accuracy specification, it should be treated as a zero in Equation 1. The voltmeter must be used on the lowest range that can measure 100 millivolts. This range is assigned the symbol "V_r" in Equation 1. V_r is always stated as volts, i.e., 100 millivolt range equals 0.1 volts for V_r .

6-21. Equation 2 (Figure 6-6) may be used to convert the voltmeter voltage reading to current.

6-22. THEORY OF OPERATION

6-23. The schematic diagram of the Model A90 is located at the back of the manual. In the milliampere ranges, current is directed through the appropriate shunt resistor by switches S1A through S5A, and the corresponding output voltage is connected to the output terminals through switches S1 through S5, decks B and C. In 10 ampere range, the input current is applied directly to the shunt resistor, and the output voltage is connected to the output terminals through switch S6.

6-24. All shunt resistors are four-terminal shunts or are connected in a four-terminal switching arrangement so that lead resistance does not affect measurement accuracy.

6-25. MAINTENANCE

6-26. The following paragraphs contain instructions for cleaning and calibrating the Model A90.

6-27. Cleaning

6-28. The instrument should be cleaned periodically to remove dust, grease, and other contamination. The following procedure should be adhered to when cleaning the instrument:

a. Remove loose contamination with low-pressure, clean, dry air.

b. Clean front panel and exterior surfaces with anhydrous ethyl alcohol or a soft cloth dampened in a mild solution of detergent and water.

CAUTION!

Do not use aromatic hydrocarbons or chlorinated solvents on the front panel, because they will react with the Lexan binding posts.

$$I_x = I_r \times \frac{V_d}{V_{dfs}}$$

Where: I_x = magnitude of unknown current in units of A90 "RANGE" used. (i.e. ma or amps).

I_r = A90 Rated Current "RANGE".

V_d = Voltmeter reading.

V_{dfs} = Nominal Voltmeter reading with rated current flowing in A90. "V_{dfs}" and "V_r" are tabulated in Table 6-7 for each voltmeter listed in Tables 6-2 through 6-6. Note that "V_{dfs}" multiplies or divides "V_d" by powers of 10 so it is simple to manipulate.

EQUATION 2. CONVERTING VOLTAGE READINGS TO CURRENT

Example: An 8100A reads =.0643 when used with an A90 in the 10 ma range. What current is flowing?

I_r = 10 ma (A90 "Rated Current Range")

V_d = .0643 (Voltmeter reading)

V_{dfs} = .1000 (From Table 6-7)

Answer: $I_x = 10 \text{ ma} \times \frac{.0643}{.1000} = 6.43 \text{ ma}$

Figure 6-6. Equation 2 — CONVERTING VOLTAGE READINGS TO CURRENT

6-29. Test Equipment

6-30. Test equipment required for calibration and testing of the Model A90 is shown in Table 6-8. If the recommended equipment is not available, other equivalent equipment may be used.

Table 6-8. LIST OF TEST EQUIPMENT

NAME	RECOMMENDED EQUIPMENT
Constant Current Source	Fluke Model 382A
DC Differential Voltmeter	Fluke Model 895A or 885A
Low-Thermal Leads	
4-Terminal Ohmmeter	Fluke Model 8300A with Option -02

6-31. Calibration

6-32. PRELIMINARY CHECKS. Make the resistance checks shown in Table 6-9. Values are approximate since check is intended to show only gross errors, such as defective or open resistors.

6-33. .1 MA AND 1 MA RANGE CHECKS. Connect the ohmmeter and A90, as shown in Figure 6-7, for 4-terminal resistance measurements, and perform the following steps:

a. Set the A90 to the .1 MA range. The ohmmeter should indicate between 1.00050 and 0.99950 kilohms. If the measured resistance is not within these limits, the .1 MA shunt, R6, is defective and must be replaced.

b. Set the A90 to the 1 MA range. The ohmmeter should indicate between 100.07 and 99.93 ohms. If the measured resistance is not within these limits, the 1 MA shunt, R5, is defective and must be replaced.

6-34. 10 MA, 100 MA, AND 1000 MA RANGE CHECKS. Connect the constant current generator, differential voltmeter, and A90 as shown in Figure 6-8 and perform the following steps:

a. Set the A90 to the 10 MA range.

b. Set the differential voltmeter controls as follows:

RANGE	1 Volt
NULL Sensitivity	100 μV
Readout Dials	0.100000

Table 6-9. RESISTANCE CHECKS

OHMMETER CONNECTIONS	MODEL A90	
	RANGE	APPROXIMATE RESISTANCE (OHMS)
INPUT Terminals	.1 MA	1000
	1 MA	100
	10 MA	10
	100 MA	1
	1000 MA	0.1
	10A	∞
INPUT (10A Terminals)	10A	0.01
OUTPUT Terminals	10A	0.01
	1000 MA	0.1
	100 MA	1
	10 MA	10
	1 MA	100
	.1 MA	1000

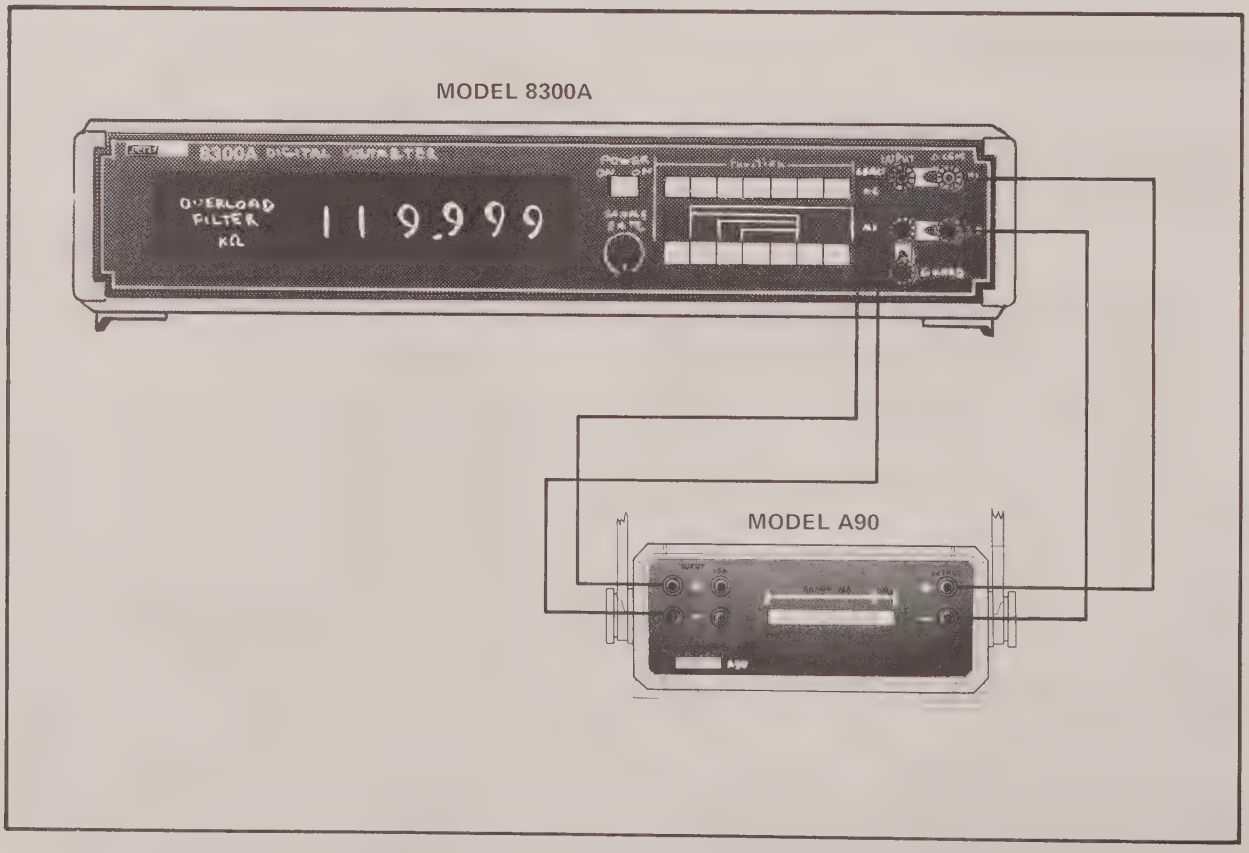


Figure 6-7. EQUIPMENT CONNECTIONS – .1 MA AND 1 MA RANGE CHECKS

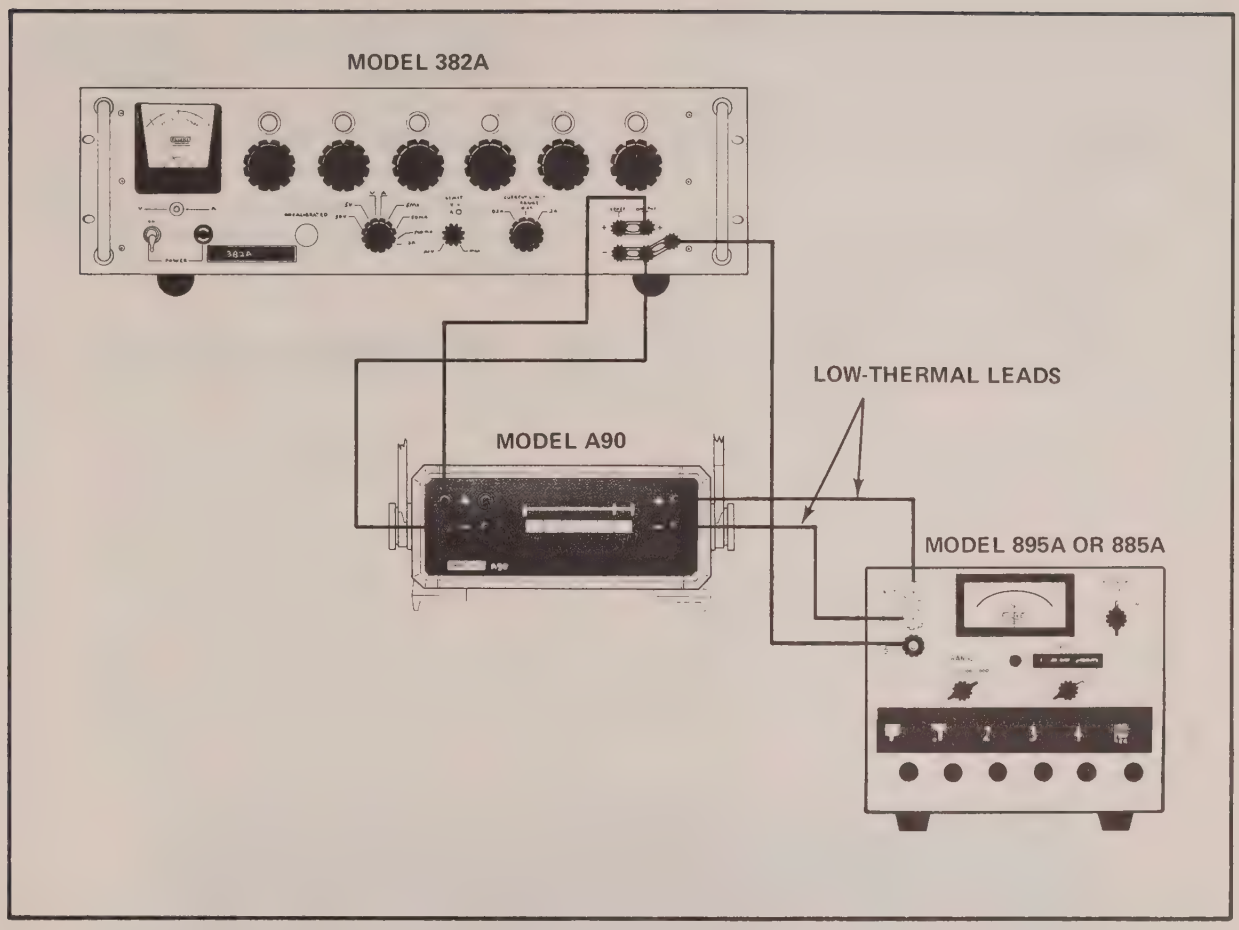


Figure 6-8. EQUIPMENT CONNECTIONS – 10 MA, 100 MA, AND 1000 MA RANGE CHECKS

c. Set the constant current generator for 10.0000 milliamperes output. The differential voltmeter should indicate null within ±80 micorvolts. If the voltmeter does not indicate within these limits, the 10 MA shunt, R4, is defective and must be replaced.

d. Change the A90 range to 100 MA and the constant current generator output to 100 milliamperes. The differential voltmeter should indicate null within ±80 microvolts. If the voltmeter does not indicate within these limits, the 100 MA shunt, R3, is defective and must be replaced.

e. Change the A90 range to 1000 MA and the constant current generator output to 1000 milliamperes. The differential voltmeter should indicate null within ±80 microvolts. If the +80 microvolt limit is not met, the 1000 MA shunt, R2, should be replaced. If the –80 microvolt limit is not met, R2 is low in ohmic value and can be trimmed to its desired value by carefully removing a small amount of material from the edge of the shunt using a whetstone.

6-35. 10 AMPERE RANGE CHECK. Connect equipment as shown in Figure 6-8, leaving the constant current generator temporarily disconnected from the A90, and perform the following steps:

a. Set the differnetial voltmeter controls as follows:

RANGE	1 Volt
NULL Sensitivity	100 μV
Readout Dials	0.00000

The voltmeter should indicate less than ±4 microvolts of thermal offset. If more than ±4 microvolts of offset is observed, check for cold solder joints or possible thermal generators in the test

setup. When thermal offset has been reduced to within ±4 microvolts, proceed to step (b).

b. Connect the constant current generator to the 10 AMP binding posts of the A90 and set the A90 to the 10A range.

c. Set the differential voltmeter controls as follows:

RANGE	1 Volt
NULL Sensitivity	100 μV
Readout Dials	.020000

d. Set the constant current generator output to 2 amperes. The voltmeter should indicate null within ±80 microvolts. If the +80 microvolt limit is not met, the 10 ampere shunt, R1, should be replaced. If the −80 microvolt limit is not met, R1 is low in ohmic value and can be trimmed to its desired value by carefully removing a small amount of material from the edge of the shunt using a whetstone.

6-36. LIST OF REPLACEABLE PARTS

REF DESIG	INDEX NO	DESCRIPTION	STOCK NO	MFR	MFR PART NO	TOT QTY	REC QTY	USE CODE
		CURRENT SHUNT – Figure 6-9	A90					
		Shunt PCB Assembly (See Figure 6-9)	A90-403	89536	A90-403	1		
J1, J2, J5		Binding post, red, +	275552	89536	275552	3		
J3, J4, J6		Binding post, black –	275560	89536	275560	3		
		Cover, bottom	224360	89536	224360	1		
		Cover, top	224352	89536	224352	1		
		Foot	230037	89536	230337	4		
		Handle, carrying	231423	89536	231423	1		
		Panel, front	A90-208	89536	A90-208	1		
		Panel, rear	A90-209	89536	A90-209	1		

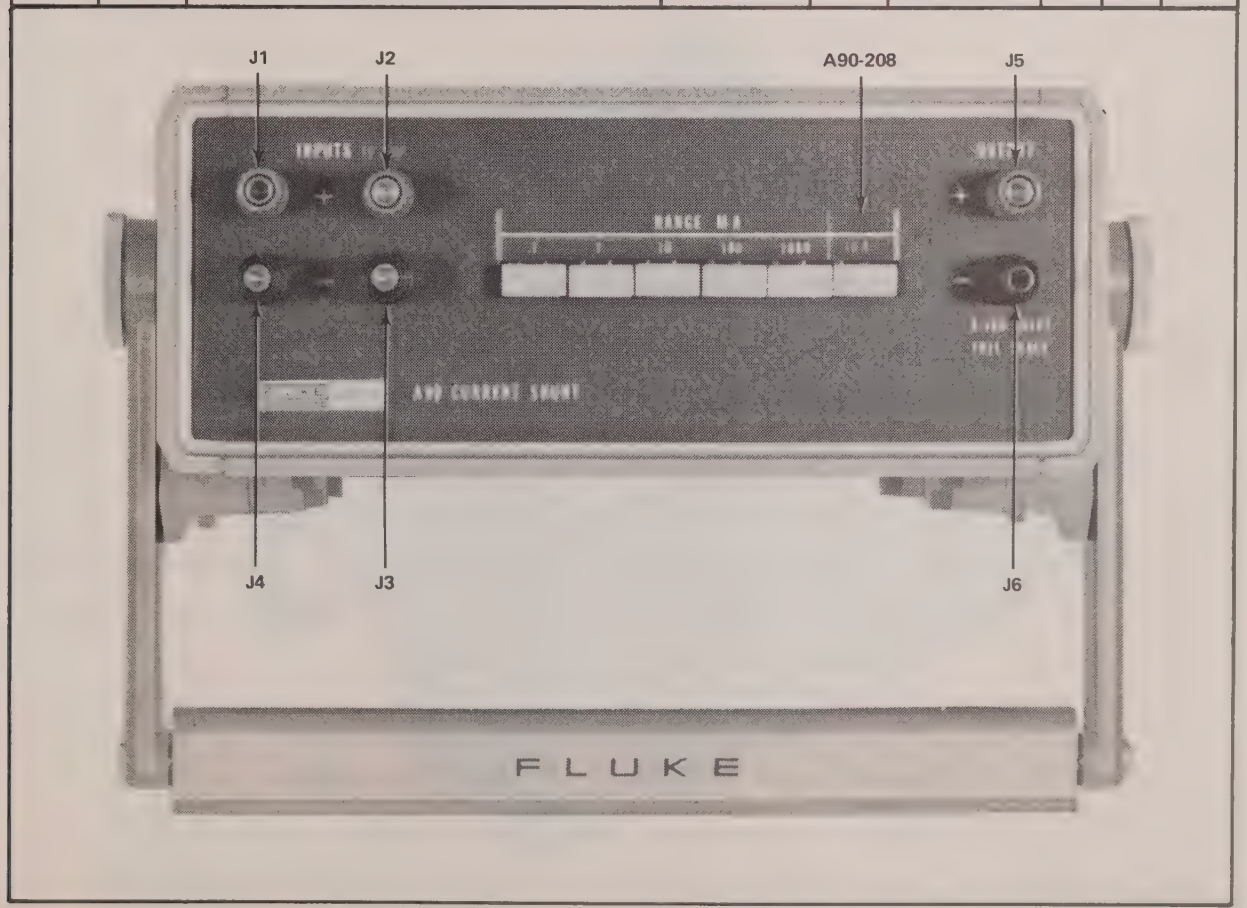


Figure 6-9. MODEL A90 CURRENT SHUNT (Sheet 1 of 2)

REF DESIG	INDEX NO	DESCRIPTION	STOCK NO	MFR	MFR PART NO	TOT QTY	REC QTY	USE CODE
		SHUNT PCB ASSEMBLY – Figure 6-9	A90-403	89536	A90-403	REF		
R1		Res, ww, 0.010Ω ±0.2%, 1w	34-4022	89536	34-4022	1		
R2		Res, ww, 0.10Ω ±0.1%, 1w	224121	89536	224121	1		
R3		Res, ww, 1.0Ω ±0.1%, ½w	224089	89536	224089	1		
R4		Res, ww, 10Ω ±0.1%, ½w	224071	89536	224071	1		
R5		Res, ww, 100Ω ±0.03%, ½w	155846	89536	155846	1		
R6		Res, ww, 1 KΩ ±0.04%, ½w	131706	89536	131706	1		
S1 thru S6		Switch assembly, RANGE MA	A90-802	89536	A90-802	1		

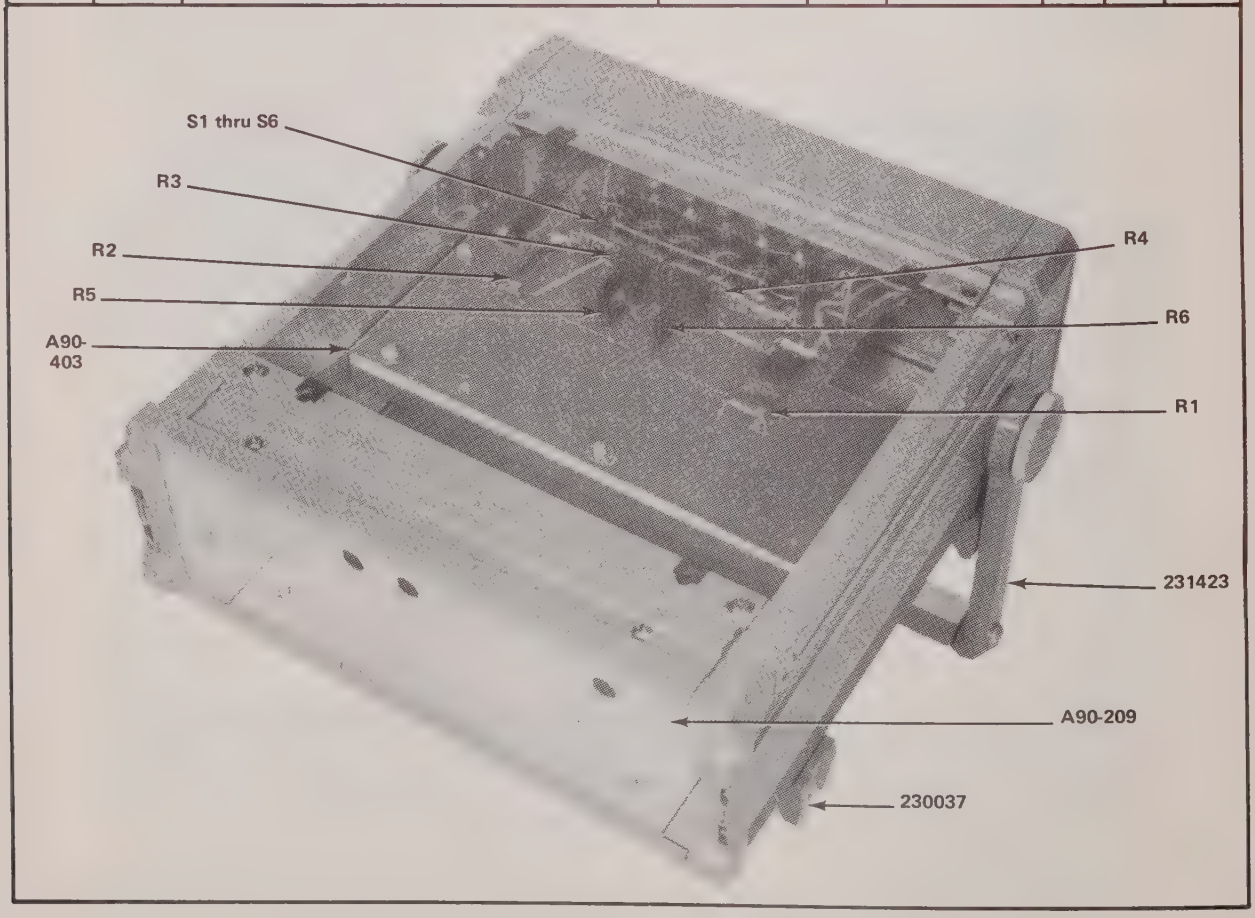
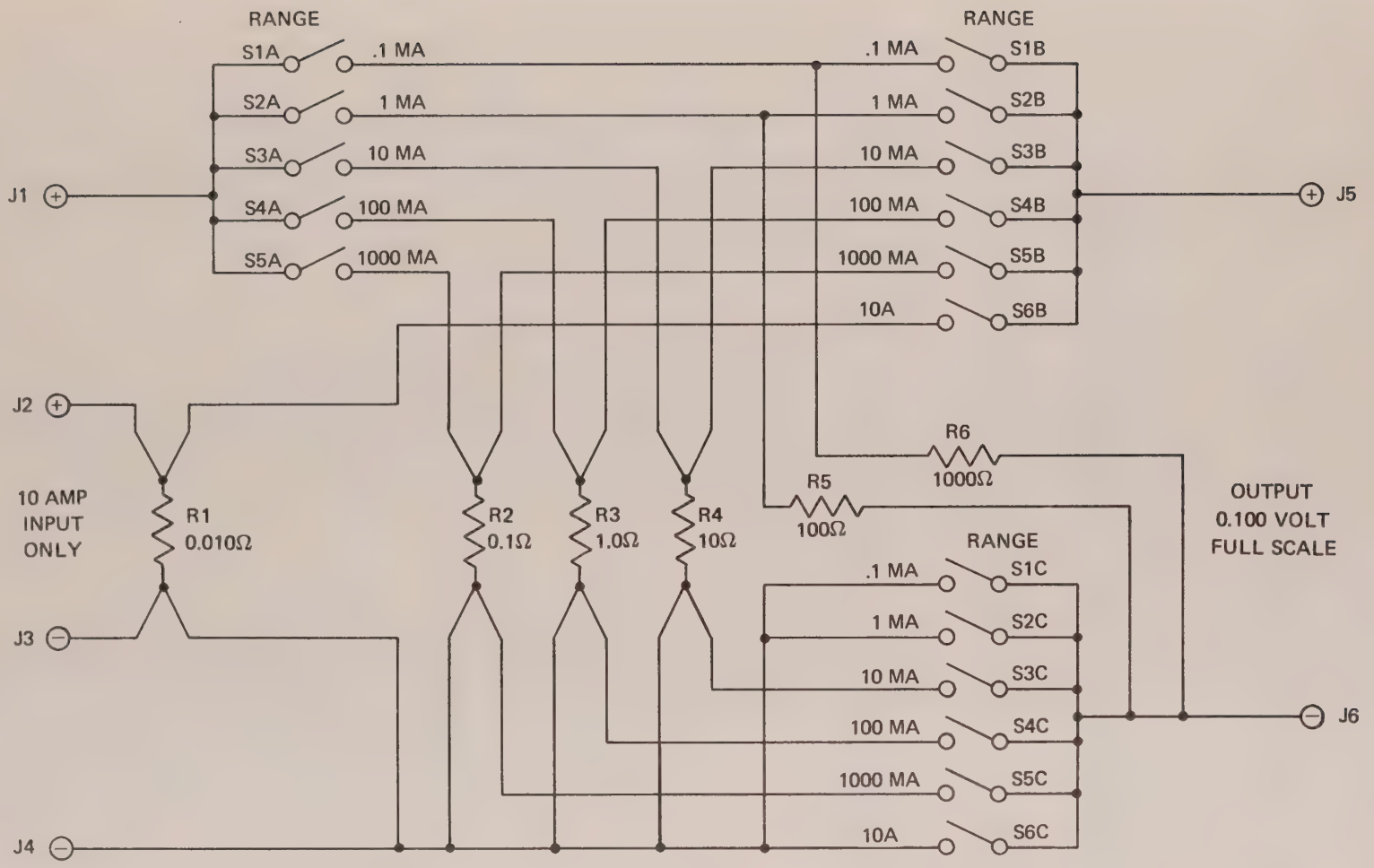


Figure 6-9. MODEL A90 CURRENT SHUNT (Sheet 2 of 2)



FUNCTIONAL SCHEMATIC DIAGRAM	
MODEL A90 CURRENT SHUNT	
SER. NO. 123 & ON	REV. a
FLUKE JOHN FLUKE MFG. CO., INC. P.O. Box 7428 Seattle, Washington 98133	

Appendix A

Federal Supply Code for Manufacturers

A-1. CODE TO NAME

A-2. The following five-digit code numbers are listed in numerical sequence along with the manufacturer's name and address to which the code has been assigned. The Federal Supply Code has been taken from Cataloging Handbook H 4-2, Code to Name.

00213 Sage Electronics Corp.
Rochester, New York

00327 Welwyn International, Inc.
Westlake, Ohio

00656 Aerovox Corp.
New Bedford, Massachusetts

00779 AMP Inc.
Harrisberg, Pennsylvania

01121 Allen-Bradley Co.
Milwaukee, Wisconsin

01281 TRW Semiconductors
Lawndale, California

01295 Texas Instruments, Inc.
Semiconductor Components Div.
Dallas, Texas

01686 RCL Electronics Inc.
Manchester, New Hampshire

01730 Deleted

01884 Dearborn Electronics Inc.
Orlando, Florida

02114 Ferroxcube Corp.
Saugerties, New York

02606 Replaced by 15801

02660 Amphenol-Borg Elect. Corp.
Broadview, Illinois

02799 Arco Capacitors, Inc.
Los Angeles, California

03614 Replaced by 71400

03651 Replaced by 44655

03797 Eldema Corp.
Compton, California

03877 Transitron Electronic Corp.
Wakefield, Massachusetts

03888 Pyrofilm Resistor Co., Inc.
Cedar Knolls, New Jersey

03911 Clairex Corp.
New York, New York

03980 Mulrhead Instruments, Inc.
Mountainside, New Jersey

04009 Arrow Hart and Hegemen
Electronic Company
Hartford, Connecticut

04062 Replaced by 72136

04202 Replaced by 81312

04217 Essex Wire Corp
Wire & Cable Div.
Anaheim, California

04221 Aemco
Div. of Midtex Inc.
Mankato, Minnesota

04645 Replaced by 75376

04713 Motorola Semiconductor
Products Inc.
Phoenix, Arizona

05082 Replaced by 94154

05236 Jonathan Mfg. Co.
Fullerton, California

05277 Westinghouse Electric Corp.
Semiconductor Dept.
Youngwood, Pennsylvania

05278 Replaced by 43543

05397 Union Carbide Corp.
Electronics Div.
Cleveland, Ohio

05571 Sprague Electric Co
Pacific Div.
Los Angeles, California

05704 Alac, Inc.
Glendale, California

05820 Wakefield Engineering Ind.
Wakefield, Massachusetts

06001 General Electric Company
Capacitor Department
Irmo, South Carolina

06136 Replaced by 63743

06473 Amphenol Space & Missile Sys.
Chatsworth, California

06555 Beede Electrical Instrument Co.
Penacook, New Hampshire

06739 Electron Corp.
Littletown, Colorado

06743 Clevite Corp.
Cleveland, Ohio

06751 Semcor Div. Components
Phoenix, Arizona

06860 Gould National Batteries Inc.
City of Industry, California

06980 Eitel-McCullough, Inc.
San Carlos, California

07115 Replaced by 14674

07138 Westinghouse Electric Corp
Electronic Tube Div.
Elmira, New York

07263 Fairchild Semiconductor
Div. of Fairchild Camera
& Instrument Corp.
Mountain View, California

07344 Bircher Co., Inc.
Rochester, New York

07792 Lerma Engineering Corp
Northampton, Massachusetts

07910 Continental Device Corp.
Hawthorne, California

08530 Reliance Mica Corp.
Brooklyn, New York

08792 CBS Electronics Semiconductor
Operations-Div. of CBS Inc.
Lowell, Massachusetts

08806 General Electric Co.
Miniature Lamp Dept.
Cleveland, Ohio

08863 Nylomatic Corp.
Norrisville, Pennsylvania

08988 Skottie Electronics Inc.
Archbald, Pennsylvania

09922 Burndy Corp.
Norwalk, Connecticut

11237 Chicago Telephone of Calif. Inc.
South Pasadena, California

11358 CBS Electronics
Div. of CBS Inc.
Newburyport, Massachusetts

11403 Best Products Co.
Chicago, Illinois

11503 Keystone Mfg
Div. of Avis Industrial Corp.
Warren, Michigan

12014 Chicago Rivet & Machine Co.
Bellwood, Illinois

12040 National Semiconductor Corp.
Danburry, Connecticut

12060 Diodes, Inc.
Chatsworth, California

12136 Philadelphia Handle Co.
Camden, New Jersey

12323 Presin Co., Inc.
Shelton, Connecticut

12327 Freeway Washer & Stamping Co.
Cleveland, Ohio

12400 Replaced by 75042

12617 Hamlin Inc.
Lake Mills, Wisconsin

12697 Clarostat Mfg. Co.
Dover, New Hampshire

12749 James Electronics
Chicago, Illinois

12856 Micrometals
Sierra Madre, California

12954 Dickson Electronics Corp.
Scottsdale, Arizona

13606 Sprague Electric Co.
Transistor Div.
Concord, New Hampshire

13839 Replaced by 23732

14099 Semtech Corp.
Newbury Park, California

14193 California Resistor Corp.
Santa Monica, California

14298 American Components, Inc.
Conshohocken, Pennsylvania

14655 Cornell-Dubilier Electronics
Newark, New Jersey

14674 Corning Glass Works
Corning, New York

14752 Electro Cube Inc.
San Gabriel, California

14869 Replaced by 96853

15636 Elec-Trol Inc.
Northridge, California

15801 Fenwal Electronics Inc.
Framingham, Massachusetts

15818 Amelco Semiconductor
Div. of Teledyne Inc.
Mountain View, California

15849 Useco, Inc.
Mt. Vernon, New York

15909 Replaced by 17870

16332 Replaced by 28478

16473 Cambridge Scientific Ind. Inc.
Cambridge, Maryland

16742 Paramount Plastics
Downey, California

16758 Delco Radio
Div. of General Motors
Kokomo, Indiana

17069 Circuit Structures Lab.
Upland, California

17856 Siliconix, Inc.
Sunnyvale, California

17870 Daven-Div. of Thomas A. Edison
Ind. --McGraw-Edison Co.
Manchester, New Hampshire

18083 Deleted

18178 Vactec Inc.
Maryland Heights, Missouri

18736 Voltronics Corp.
Hanover, New Jersey

19429 Montronics, Inc.
Seattle, Washington

19451 Perine Machinery & Supply Co.
Seattle, Washington

19701 Electra Mfg. Co.
Independence, Kansas

20584 Enochs Mfg. Co.
Indianapolis, Indiana

22767 ITT Semiconductors
Div. of ITT
Palo Alto, California

23732 Tracor
Rockville, Maryland

24248 Southco
Div. of South Chester Corp.
Lester, Pennsylvania

24655 General Radio Co.
West Concord, Massachusetts

25403 Amperex Electronic Corp
Semiconductor & Receiving
Tube Division
Slatersville, Rhode Island

28478 Deltrol Controls Corp.
Milwaukee, Wisconsin

28520 Heyman Mfg. Co.
Kenilworth, New Jersey

30323 Illinois Tool Works Inc.
Chicago, Illinois

33173 General Electric Co.
Tube Dept.
Owensboro, Kentucky

37942 Mallory, P. R., & Co., Inc.
Indianapolis, Indiana

38315 Honeywell Inc.
Precision Meter Div.
Manchester, New Hampshire

42498 National Company
Melrose, Massachusetts

43543 Nytronics Inc.
Transformer Co. Div.
Alpha, New Jersey

44655 Ohmite Mfg. Co
Skokie, Illinois

49671 Radio Corp. of America
New York, New York

49956 Raytheon Company
Lexington, Maine

53021 Sangamo Electric Co.
Springfield, Illinois

55026 Simpson Electric Company
Chicago, Illinois

56289 Sprague Electric Co.
North Adams, Massachusetts

58474 Superior Electric Co.
Bristol, Connecticut

60399 Torrington Mfg. Co.
Torrington, Connecticut

62460 Deleted

63743 Ward Leonard Electric Co.
Mount Vernon, New York

64834 West Mfg. Co.
San Francisco, California

65092 Weston Instruments Inc.
Newark, New Jersey

66150 Winslow Tele-Tronics Inc.
Asbury Park, New Jersey

70563 Amperite Company
Union City, New Jersey

70903 Belden Mfg. Co.
Chicago, Illinois

71002 Birnbach Radio Co., Inc.
New York, New York

71400 Bussmann Mfg.
Div. of McGraw-Edison Co.
St. Louis, Missouri

71450 CTS Corp.
Elkhart, Indiana

71468 ITT Cannon Electric Inc.
Los Angeles, California

71482 Clare, C P. & Co.
Chicago, Illinois

71590 Centralab
Div. of Globe Union Inc.
Milwaukee, Wisconsin

71707 Coto Coil Co., Inc.
Providence, Rhode Island

71744 Chicago Miniature Lamp Works
Chicago, Illinois

71785 Cinch Mfg. Co. & Howard
B. Jones Div.
Chicago, Illinois

72005 Driver, Wilber B., Co.
Newark, New Jersey

72092 Replaced by 06980

72136 Electro Motive Mfg. Co.
Willimantic, Connecticut

72259 Nytronics Inc.
Berkeley Heights, New Jersey

72354 Deleted

72619 Dialight Corp
Brooklyn, New York

72653 G. C. Electronics
Rockford, Illinois

72665 Replaced by 90303

72794 Dzus Fastener Co., Inc.
West Islip, New York

72928 Gudeman Co.
Chicago, Illinois

72982 Erie Tech. Products Inc.
Erie, Pennsylvania

73138 Beckman Instruments Inc.
Helipot Division
Fullerton, California

73293 Hughes Aircraft Co.
Electron Dynamics Div.
Newport Beach, California

73445 Amperex Electronic Corp.
Hicksville, New York

73559 Carling Electric Inc.
Hartford, Connecticut

73586 Circle F Industries
Trenton, New Jersey

73734 Federal Screw Products, Inc.
Chicago, Illinois

73743 Fischer Special Mfg. Co.
Cincinnati, Ohio

73899 JFD Electronics Co.
Brooklyn, New York

73949 Guardian Electric Mfg. Co.
Chicago, Illinois

74199 Quam Nichols Co.
Chicago, Illinois

74217 Radio Switch Corp.
Marlboro, New Jersey

74276 Signalite Inc.
Neptune, New Jersey

74306 Piezo Crystal Co.
Carlisle, Pennsylvania

74542 Hoyt Elect. Instr. Works
Penacook, New Hampshire

74970 Johnson, E. F., Co.
Waseca, Minnesota

75042 IRC Inc.
Philadelphia, Pennsylvania

75376 Kurz-Kasch, Inc.
Dayton, Ohio

75382 Kulka Electric Corp.
Mt. Vernon, New York

75915 Littlefuse Inc.
Des Plaines, Illinois

76854 Oak Mfg. Co.
Crystal Lake, Illinois

77342 Potter & Brumfield
Div. of Amer. Machine & Foundry
Princeton, Indiana

77969 Rubbercraft Corp. of Calif. LTD.
Torrance, California

78189 Shakeproof
Div. of Illinois Tool Works
Elgin, Illinois

78277 Sigma Instruments, Inc.
South Braintree, Massachusetts

78488 Stackpole Carbon Co.
St. Marys, Pennsylvania

78553 Tinnerman Products
Cleveland, Ohio

79136 Waldes Kohinoor Inc.
Long Island City, New York

79497 Western Rubber Company
Goshen, Indiana

79963 Zierick Mfg. Corp.
New Rochelle, New York

80031 Mepco
Div. of Sessions Clock Co.
Morristown, New Jersey

80145 API Instruments Co.
Chesterland, Ohio

80183 Sprague Products
North Adams, Massachusetts

80294 Bourns Inc.
Riverside, California

80583 Hammarlund Co., Inc.
Mars Hill, North Carolina

80640 Stevens, Arnold Inc.
Boston, Massachusetts

81073 Grayhill Inc.
La Grange, Illinois

81312 Winchester Electronics
Div. of Litton Industries
Oakville, Connecticut

81439 Therm-O-Disc Inc.
Mansfield, Ohio

81483 International Rectifier Corp.
El Segundo, California

81590 Korry Mfg. Co.
Seattle, Washington

82376 Deleted

82389 Switchcraft Inc.
Chicago, Illinois

82415 Price Electric Corp.
Frederick, Maryland

82872 Roanwell Corp.
New York, New York

82877 Rotron Mfg. Co., Inc.
Woodstock, New York

82879 ITT Wire & Cable Div.
Pawtucket, Rhode Island

83003 Varo Inc.
Garland, Texas

83298 Bendix Corp.
Electric Power Division
Eatontown, New Jersey

83330 Smith, Herman H., Inc.
Brooklyn, New York

83478 Rubbercraft Corp. of America
New Haven, Connecticut

83594 Burroughs Corp.
Electronic Components Div.
Plainfield, New Jersey

83740 Union Carbide Corp.
Consumer Products Div.
New York, New York

84171 Arco Electronics, Inc.
Great Neck, New York

84411 TRW
Ogallala, Nebraska

86577 Precision Metal Products
Stoneham, Massachusetts

86684 Radio Corp. of America
Electronic Components &
Devices
Harrison, New Jersey

86689 Deleted

87034 Marco-Oak Inc.
Anaheim, California

88419 Use 14655

88690 Replaced by 04217

89536 Fluke, John Mfg. Co., Inc.
Seattle, Washington

89730 Replaced by 08806

90201 Mallory Capacitor Co.
Indianapolis, Indiana

90215 Best Stamp & Mfg. Co.
Kansas City, Missouri

90211	Square D Co. Chicago, Illinois
90303	Mallory Battery Co. Tarrytown, New York
91293	Johanson Mfg. Co. Boonton, New Jersey
91407	Replaced by 58474
91637	Dale Electronics Inc. Columbus, Nebraska
91662	Elco Corp. Willow Grove, Pennsylvania
91737	Gremar Mfg. Co., Inc. Wakefield, Massachusetts
91802	Industrial Devices, Inc. Edgewater, New Jersey
91836	King's Electronics Tuckahoe, New York
91929	Honeywell Inc. Micro Switch Div. Freeport, Illinois
91934	Miller Electric Co., Inc. Pawtucket, Rhode Island
93332	Sylvania Electric Products Semiconductor Products Div. Woburn, Massachusetts
94145	Replaced by 49956
94154	Tung-Sol Div. of Wagner Electric Corp. Newark, New Jersey
95146	Alco Electronics Products Inc. Lawrence, Massachusetts
95263	Leecraft Mfg. Co. Long Island City, New York
95264	Replaced by 98278
95275	Vitramon Inc. Bridgeport, Connecticut
95303	Radio Corp. of America Solid State & Receiving Tube Div. Cincinnati, Ohio
95354	Methode Mfg. Corp. Rolling Meadows, Illinois
95712	Dage Electric Co., Inc. Franklin, Indiana
95987	Weckesser Co., Inc. Chicago, Illinois
96733	San Fernando Electric Mfg. Co. San Fernando, California
96853	Rustrak Instrument Co. Manchester, New Hampshire
96881	Thomson Industries, Inc. Manhasset, New York
97540	Master Mobile Mounts Div. of Whitehall Electronics Corp. Los Angeles, California
97913	Industrial Electronic Hdware Corp. New York, New York
97945	White, S. S. Co. Plastics Div. New York, New York
97966	Replaced by 11358
98094	Replaced by 49956
98278	Microdot Inc. Pasadena, California
98291	Sealectro Corp. Conhex Div Mamaroneck, New York
98388	Accurate Rubber & Plastics Culver City, California
98743	Replaced by 12749
98925	Deleted
99120	Plastic Capacitors, Inc. Chicago, Illinois
99217	Southern Electronics Corp. Burbank, California
99515	Marshall Industries Capacitor Div. Monrovia, California

SALES & SERVICE REPRESENTATIVES

ALABAMA
HUNTSVILLE
BCS Associates, Inc.
3322 South Memorial Parkway
Tel. (205) 881-6220
Zip 35801

ALASKA
SEATTLE
Instrument Specialists, Inc.
5950 Sixth Ave. South
Suite 106
Seattle, Washington 98108
Tel. (206) 767-4260

ARIZONA
PHOENIX
Barnhill Associates
4900 E. Indian School Road
Tel. (602) 959-2115
Zip 85251

CALIFORNIA
LOS ANGELES
Instrument Specialists, Inc.
1109 S. Central Ave.
Glendale, California 91204
Tel. (213) 245-9404

SAN FRANCISCO
Instrument Specialists, Inc.
2359 De La Cruz
Santa Clara, California 95050
Tel. (408) 244-1505

SAN DIEGO
Instrument Specialists, Inc.
10459 A Rosella Street
San Diego, California 92121
Tel. (714) 453-1833

COLORADO
DENVER
Barnhill Associates
1170 S. Sheridan Blvd.
Tel. (303) 934-5505
Zip 80226

CONNECTICUT
HARTFORD
Instrument Representatives, Inc.
P.O. Box 165
Glastonbury, Connecticut 06033
Tel. (203) 633-0777

FLORIDA
ORLANDO
BCS Associates, Inc.
940 N. Fern Creek Ave.
Tel. (305) 843-1510
Zip 32803

HAWAII
HONOLULU
Industrial Electronics, Inc.
646 Queen Street
Tel. (808) 506-095
Zip 96813

ILLINOIS
CHICAGO
Cozzens & Cudahy, Inc.
9501 W. Devon Ave.
Rosemont, Illinois 60018
Tel. (312) 825-1144

INDIANA
INDIANAPOLIS
Cozzens & Cudahy, Inc.
647 Mulford Crt.
Tel. (317) 244-2456
Zip 46234

MARYLAND
BALTIMORE
Electronic Marketing Assoc.
11501 Huff Court
Kensington, Maryland 20795
Tel. (301) 881-5300

MASSACHUSETTS
BOSTON
Instrument Representatives, Inc.
1046 Massachusetts Avenue
Arlington, Massachusetts 02174
Tel. (617) 646-1034

MICHIGAN
DETROIT
Technitron, Inc.
13657 Grand River Ave.
Tel. (313) 838-7324
Zip 48227

MINNESOTA
MINNEAPOLIS
Cozzens & Cudahy, Inc.
7710 Computer Ave.
Tel. (612) 920-1022
Zip 55435

MISSOURI
ST. LOUIS
Cozzens & Cudahy, Inc.
P.O. Box 10013
Lambert Field 63145
Tel. (314) 423-1234

NEW JERSEY
NEWARK
SBM Associates, Inc.
1519 Stuyvesant Avenue
Union, New Jersey 07083
Tel. (201) 687-8737

NEW MEXICO
ALBUQUERQUE
Barnhill Associates
827 Pennsylvania N.E.
Tel (505) 265-7766
Zip 87110

NEW YORK
NEW YORK
SBM Associates, Inc.
28 Hobby Street
Pleasantville, New York 10570
Tel. (914) 769-1811

LONG ISLAND
SBM Associates, Inc.
528 Old Country Road
Plainview, Long Island 11803
Tel. (516) 433-1421

ROCHESTER
SBM Associates, Inc.
800 Linden Avenue
Tel. (716) 381-8330
Zip 14625

SYRACUSE
SBM Associates, Inc.
138 Pickard Bldg.
5858 E. Molloy Road
Tel. (315) 454-9377
Zip 13211

NORTH CAROLINA
GREENSBORO
BCS Associates, Inc.
1039 E. Wendover Avenue
Tel. (919) 273-1918
Zip 27405

OHIO
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Technitron, Inc.
23203 Lorain Road
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Tel. (216) 734-0960

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Technitron, Inc.
1250 W. Dorothy Lane
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Zip 45409

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Instrument Specialists, Inc.
5650 Sixth Ave. South
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Seattle, Washington 98108
Tel. (206) 767-4260

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PHILADELPHIA
Electronic Marketing Assoc.
210 Goddard Blvd. – Suite 100
King of Prussia, Pennsylvania
Tel. (215) 248-5050
Zip 19406

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Technitron, Inc.
114 Spring Grove Road
Tel. (412) 371-1231
Zip. 15235

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Barnhill Associates
Ste. 220
312 N. Central Express Way
Richardson, Texas 75080
Tel. (214) 231-2573

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3810 Westheimer
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11501 Huff Court
Kensington, Maryland 20795
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BRITISH COLUMBIA
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Allan Crawford Associates, Ltd.
721 Aldford Ave.
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New Westminister
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376 Churchill Avenue – Suite 106
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Allan Crawford Associates, Ltd.
65 Martin Ross Avenue
Downsview, Ontario
Tel. (416) 636-4910

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MONTREAL, 8
Allan Crawford Associates, Ltd.
1285 Hodge Street
Tel. (514) 747-9849

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Elmeasco Instruments
7 Chard Road
P.O. Box 334
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Elmeasco Instruments (Pty.) Ltd.
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C.N. Rood S/A
30 Rue Leon Frederic
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Copenhagen, Denmark

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Postbox 52025
Helsinki 25, Finland

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Radio Equipment Antares
9, Rue Ernest Cognac Q
92 Levallois
Perret, France

HONG KONG
Gilman & Co. Ltd.
P.O. Box 56
Hong Kong, Hong, Kong

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R.D.T. Electronics Engineering Ltd.
P.O. Box 21082
Tel-Aviv, Israel

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7, P.zza DeAngeli
20146 Milano, Italy

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Toyo Trading Co., Ltd.
P.O. Box 5014
Tokyo Japan

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2-38 Junkeicho-dori minami-ku
Osada, Japan

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M.-C International
I.P.O. Box 1355
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West Malaysia

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Morgenstierne & Co. A/S
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P.O. Box 26
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Singapore

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Johannesburg, So. Africa

K. Baker (Pty.) Ltd.
P.O. Box 3641
Cape Town, So. Africa

K. Baker (Pty.) Ltd.
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Durban, Natal, So. Africa

K. Baker (Pty.) Ltd.
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Swazilad, So. Africa

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General Sanjurjo, 18
Madrid, Spain

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Erik Ferner AB
Box 56
161.26 Stockholm-Bromma,
Sweden

SWITZERLAND
Omni Ray AG
Dofourstrasse 56
8008 Zurich, Switzerland

TAIWAN
Heighten Trading Co., Ltd.
P.O. 1408
Taipei, Taiwan

THIALAND
G. Simon Radio Ltd.
30 Patpong Avenue
Suriwong
Bangkok, Thailand

THE UNITED KINGDOM
Fluke International Corp.
Garnett Close
Watford, England
WD2-4TT

In Europe contact FLUKE NEDERLAND, N. V., Post Office Box 5053, Tilburg, The Netherlands

List of Factory Authorized Service Centers

ARIZONA

PHOENIX

Arizona Standards Laboratory
4430 N. 19th Ave.
Tel. (602) 264-9351

CALIFORNIA

LOS ANGELES

Instrument Specialists, Inc.
P. O. Box 39908
2870 Los Feliz Place
Tel. (213) 665-5181
TWX: 910-321-3914

COLORADO

BOULDER

Ball Brothers Research Corp.
Standardization Laboratory
Tel. (303) 444-5300
TWX: 910-940-3241

FLORIDA

ORLANDO

BCS Associates, Inc.
P. O. Box 6578
940 N. Fern Creek Ave.
Tel. (305) 425-2764
TWX. 810-850-0185

HAWAII

HONOLULU

Industrial Electronics
P. O. Box 135
646 Queen Street
Tel. (808) 506-095
TWX. 63238

MARYLAND

KENSINGTON

Electronic Marketing Associates
11501 Huff Court
Tel. (301) 946-0300
TWX. 710-825-9645

MASSACHUSETTS

ARLINGTON

Instrument Representatives, Inc.
1046 Massachusetts Ave.
Tel. (617) 646-1034

NEW MEXICO

ALBUQUERQUE

EG & G Standards and Calibration
Laboratory
P. O. Box 4339, Station A
933 Bradbury Drive S. E.
Tel. (505) 842-4084

NEW YORK

PLEASANTVILLE

SBM Associates
28 Hobby Street
Tel. (914) 769-1811
TWX. 710-572-2193

ROCHESTER

SBM Associates
800 Linden Ave.
Tel. (716) 381-8330
TWX. 510-253-6145

OHIO

CLEVELAND

Honeywell Metrology Service
1001 E. 55th St.
Tel. (216) 881-0300

FAIRBORN

Honeywell Metrology Service
600 East Dayton Dr.
Tel. (513) 878-2551

TEXAS

GARLAND

Tucker Electronics Company
326 Kirby Street
Tel. (214) 272-3404

HOUSTON

Linear Standards Laboratory
8207 Millet
Tel. (713) 923-2796

UTAH

SALT LAKE CITY

Stabro Laboratory
23 Kensington Ave.
Tel. (801) 467-8011

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65 Martin Ross Ave.
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INTERNATIONAL

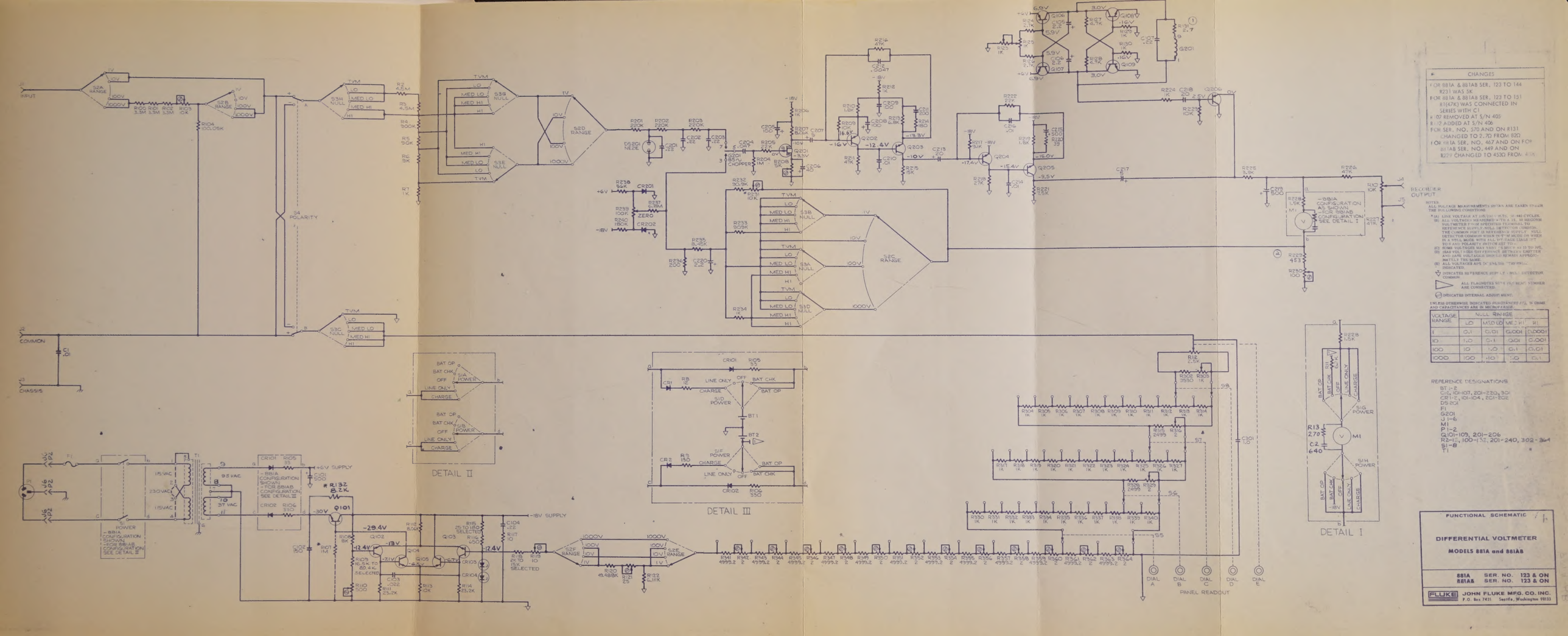
THE NETHERLANDS

Fluke Netherland N. V.
P. O. Box 5053
Tilburg, The Netherlands

UNITED KINGDOM

Fluke International Corp
P. O. Box 102
Watford-Herts, England

For information regarding service centers in other foreign locations, contact the nearest Sales and Service Representative in your area.


CHANGES
FOR 881A & 881AB SER. 123 TO 144
R231 WAS 5K
FOR 881A & 881AB SER. 123 TO 151
R1(47K) WAS CONNECTED IN SERIES WITH C1
R107 REMOVED AT S/N 405
R107 ADDED AT S/N 406
FOR SER. NO. 370 AND ON R131 CHANGED TO 2.70 FROM 820
FOR 881A SER. NO. 467 AND ON FOR 881AB SER. NO. 449 AND ON R239 CHANGED TO 453Ω FROM 453
RECORDER OUTPUT
NOTES:
ALL VOLTAGE MEASUREMENTS OBTAIN ARE TAKEN UNDER THE FOLLOWING CONDITIONS:
*(A) LINE VOLTAGE AT 115/230 VOLTS, 50-440 CYCLES.
(B) ALL VOLTAGES MEASURED WITH A FL 10 MEGOHM VOLTMETER FROM SPECIFIED TERMINAL TO REFERENCE SUPPLY NULL DETECTOR COMMON. THE COMMON POINT IS REFERENCE SUPPLY NULL DETECTOR COMMON WHEN IN V-T MODE OR WHEN IN A NULL MODE WITH ALL VT-TAGE LEADS OFF TO ANY POLARITY SWITCH SET TO -.
(C) SOME VOLTAGES MAY VARY 1% BOTH + AND - TO 10%.
(D) READ VOLTAGES FROM PANEL METER WHEN A METER AND DIAL VOLTAGES SHOULD BE MADE APPROX. THE SAME.
(E) ALL VOLTAGES ARE DC EXCEPT WHERE OTHERWISE INDICATED.
INDICATES REFERENCE SUPPLY - NULL DETECTOR COMMON.
ALL FLAGNOTES WITH THE SAME NUMBER ARE CONNECTED.
INDICATES INTERNAL ADJUSTMENT.
UNLESS OTHERWISE INDICATED RESISTANCES ARE IN OHMS AND CAPACITANCES ARE IN MICROFARADS.
VOLTAGE RANGE | NULL RANGE | LO | MED LO | MED HI | HI
1 | 0.1 | 0.01 | 0.001 | 0.0001
10 | 1.0 | 0.1 | 0.01 | 0.001
100 | 10 | 1.0 | 0.1 | 0.01
1000 | 100 | 10 | 1.0 | 0.1
REFERENCE DESIGNATIONS
BT 1-2
C(N) 101-107, 201-220, 301
CR 101-104, 201-205
DS 201
F1
G201
J 1-6
M1
P 1-2
Q(N)01-109, 201-206
R2-13, 100-152, 201-240, 302-344
S1-8
T1
DETAIL II
DETAIL III
DETAIL I
PANEL READOUT
FUNCTIONAL SCHEMATIC
DIFFERENTIAL VOLTMETER
MODELS 881A and 881AB
881A SER. NO. 123 & ON
881AB SER. NO. 123 & ON
FLUKE JOHN FLUKE MFG. CO. INC.
P.O. Box 7431 Seattle, Washington 98133